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PRODUCT ENGINEERING

GRAW-HILL WEEKLY FOR DESIGN ENGINEERS • JANUARY 9, 1961

what size impeller to move air?

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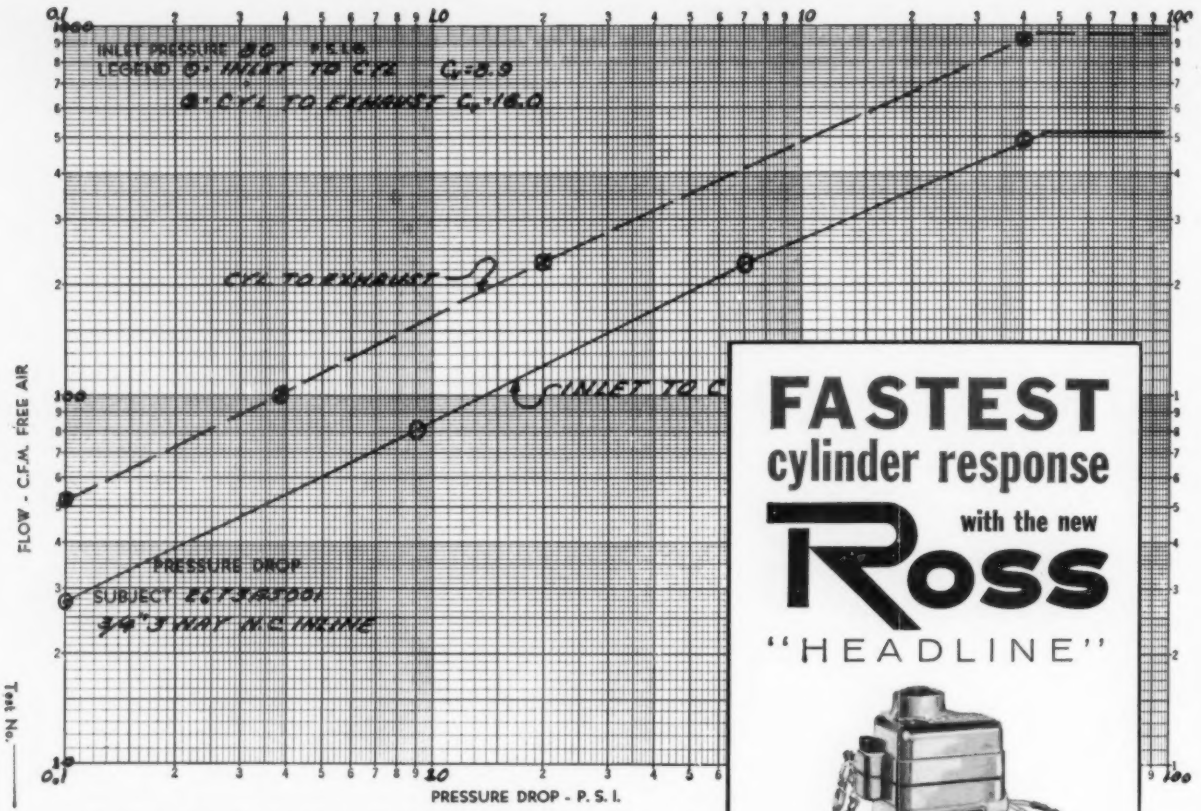
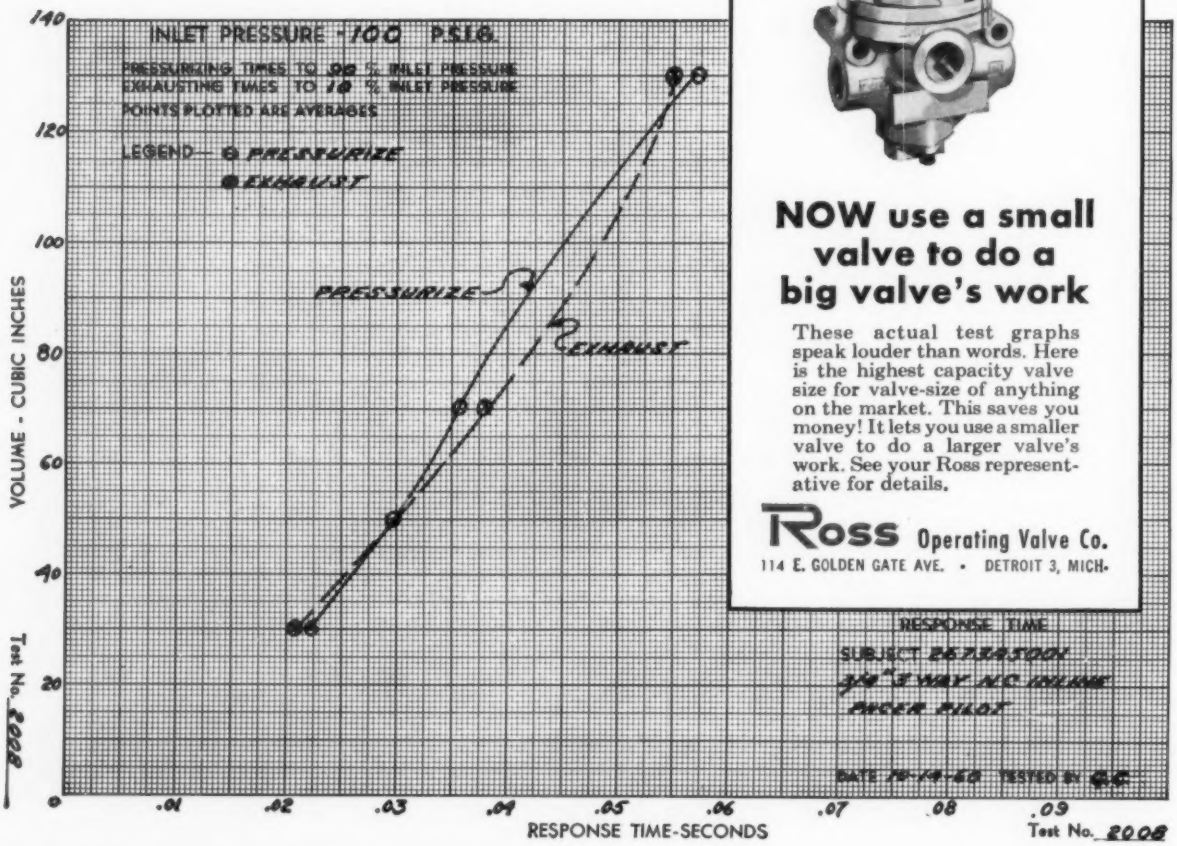
WHAT YOU CAN DO WITH FLEXIBLE MAGNETS . . . page 65

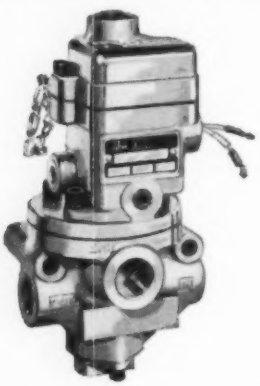
MULTIMETAL PARTS FROM CLAD METAL STRIP . . . page 69


INLET PRESSURE 80 P.S.I.G.
LEGEND ⊙ = INLET TO CYL. C_v=8.9
● = CYL. TO EXHAUST C_v=16.0
CYL. TO EXHAUST
INLET TO C
PRESSURE DROP
SUBJECT 2673R3001
3/8" 3 WAY N.C. INLINE
FLOW - C.F.M. FREE AIR
Test No.
PRESSURE DROP - P. S. I.

These graphs represent one series of tests with a random selected valve under specific conditions of pressure, temperature, humidity, fluid flow and voltage.



FASTEST cylinder response with the new Ross "HEADLINE"



NOW use a small valve to do a big valve's work

These actual test graphs speak louder than words. Here is the highest capacity valve size for valve-size of anything on the market. This saves you money! It lets you use a smaller valve to do a larger valve's work. See your Ross representative for details.

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PRODUCT ENGINEERING

McGRAW-HILL WEEKLY FOR DESIGN ENGINEERS

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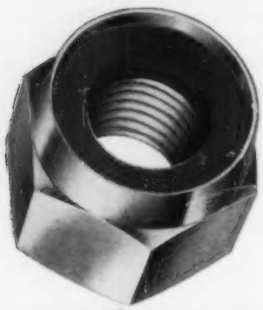
UNSHAKEABLE SELF-LOCKING PERFORMANCE IS BUILT INTO AN ELASTIC STOP NUT

Start with a standard hex nut and add a metal crown . . .



Add "the ring of reliability"— the easily identified ESNA red nylon locking insert . . .

Then roll the crown over smoothly and stake— the insert is made an integral part of the Elastic Stop nut

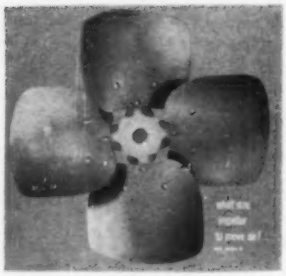
BUILD FASTENER RELIABILITY INTO YOUR PRODUCT!

Take an Elastic Stop nut and mount it on one of your products where vibration is really severe. Shake the daylights out of it in the roughest torture test you can devise—or better still—send it into the field where it's subject to regular use and abuse.

Here's what you'll find: That Elastic Stop nut will stay put! The bolt threads are impressed into the nylon locking collar with such a perfect fit that internal liquid seepage is sealed off. Internal nut and bolt threads are protected against corrosion. The nylon insert locking torque is so smooth that it never galls or distorts bolt threads; and nylon is so wear-resistant that under normal usage *you can wrench the nut on and off the bolt 50 times or more* and the nut will still remain tight under vibration! Protect the performance and the reputation of your product by guaranteeing fastener reliability. Try it yourself and see. Send for free test samples. Just tell us the size. Dept. S53-145, Elastic Stop Nut Corporation of America, 2330 Vauxhall Road, Union, New Jersey.

ESNA **ELASTIC STOP NUT CORPORATION OF AMERICA**

INTERESTING TO NOTE



On our cover—one of three basic impeller types used to set air in motion. On page 53 ." three are reviewed and the author provides a new set of equations for the designer.

President with One-track Mind

One of the most important developments in the history of American railroads was an agreement; the agreement that standardized track gage as well as brakes and couplings. (For a discussion of near-standard fasteners and how to select them, see page 75.)

About the time of the Civil War, President Lincoln became concerned over the many different track gages then in use. Trains carrying valuable implements of war across the country had to stop, unload their cargo, and have it reloaded on cars whose wheels fit on another gage track. Lincoln issued an order that the gage of all tracks be standardized at five feet. This order was never carried out, but after a great deal of wrangling among railroads, the present gage of 4 ft, 8½ in. was accepted.

This was called the "Yankee agreement" by some, and a few southern railroads refused to accept the plan. They continued using narrow-gage track as late as 1935. But aside from a few spur lines here and there, the standard is now accepted throughout the US.

Fortunately for train manufacturers this standard gage is also used in Britain, Canada and most of Europe. But India and much of South America use a wider gage (5 ft, 6 in.) while the South African roads prefer a narrow gage (3 ft, 6 in).

Australia, on the other hand, has never adopted a standard gage, so to ship cargo for long distances requires reloading or using cars with specially designed undertrucks.

The Cure That Cheers

The pre-employment patent agreement has always been a subject of controversy between employer and employe. In Europe, patent agreements vary somewhat from those in America, as the article on page 72 points out. But regardless of country, the argument continues.

Over the years, patents have been obtained on everything from specially bred plants to the shape of certain bottles. But one of the largest sources of patent applications has been home remedies. During the last century, patent medicines could be found in practically every medicine chest. The main constituent of most patent medicines is alcohol. Some of the early bitters, said to be the ideal cure for stomach ailments, had an alcohol content on a par with good bourbon whiskey. This may explain the large number of stomach ailments some of

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the so-called temperance advocates used to develop.

After the Pure Food and Drug Act was passed, patent medicines could no longer be labeled "cure" but simply "remedy." Labels were changed accordingly, with no loss in sales. One manufacturer countered the law by advertising, "If Hostetter's Stomach Bitters was not a genuine remedy for the disease to which it is adapted and an invigorant of perfect reliability, would it not long ago have been relegated to the limbo of rejected nostrums by the judgment of the American people?"

The Electric Flying Machine

In 1600, Gilbert wrote *De Magnete* (*PE*—Nov 3 '58, *p* 39), the first book to describe and name electrical attraction (he called it *electrica*). This Englishman personally demonstrated the phenomenon to the "Virgin Queen" and her court. As the news spread, Gilbert's book on magnets and electrical attraction of bodies spurred scientists to further study in this field, which had been shrouded in mystery. (The latest development in magnets is discussed on page 65.) Gilbert was the first to note many electrical effects, including the screening action of thin metal sheets, a property utilized by the shields that today encase tubes, coils and other parts of TV sets.

Burndy Library

In time, other pioneers like Robert Boyle, Francis Hauksbee and Benjamin Franklin experimented with electrical devices based on Gilbert's principles. In 1660, the first electrical generator was constructed by the burgomaster of Magedeburg, Otto von Guericke. This was not von Guericke's first contribution to science. He is better known as the inventor of an air pump (in 1645) and as the promoter of a device to demonstrate air pressure. His electrical machine paved the way for others, some of them not as practical in their approach.

The knowledge of electricity was growing, but still quite limited, and scientists of the day designed some rather fanciful contraptions. One of the strangest was the electrical flying machine envisioned at left. This art appeared originally in a 1775 French publication. The pilot was supposed to operate a gear train that rotated the two large glass spheres, thereby generating electricity, which somehow would cause this early helicopter to fly.

Benedict A Leerburger Jr

SIDELIGHT

That automated post office in Providence, RI is nearsighted—it can't tell the difference between an old canceled Russian stamp or a new American one. For that matter, the machine has accepted letters bearing stamps from Rome, New Zealand, and even Olympic souvenir stamps. Investigation has shown that the electronic equipment can't tell a trading stamp or Christmas seal from legal US postage. While engineers are rushing for the aspirin, philatelists are headed for Providence.

NEXT WEEK IN PRODUCT ENGINEERING

. . . **Your Guide to Roller and Thrust Bearings**

Described and illustrated in this Special Report are more than 90 distinct roller- and thrust-bearing configurations. The more common ones are compared on the basis of relative load capacity and speed limitation.

. . . **Blow-molding Goes Industrial**

If you need a thin-walled plastic part that isn't completely hollow, take a look at the new ways a fast-growing process is being used.

. . . **Novel Indexing Device Finds Technical Papers**

Sight through holes in home-made cards—then go directly to all pertinent information in your file drawer.

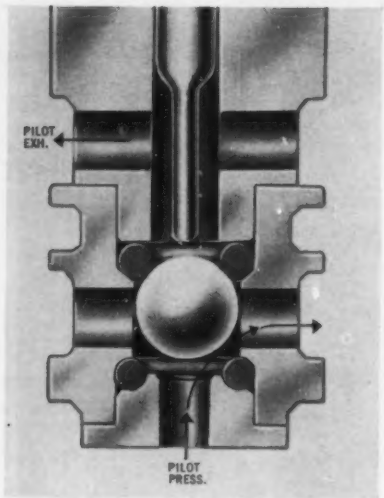
. . . **How to Build Safety into Electronics Equipment**

Guide to protecting technicians against burns, shock, flying glass and themselves.

. . . **Spring Mechanisms—Continuous Balancing**

Continuous balancing for any number of precision points is possible with odd-shape pulleys.

How To Build An Air Valve That Beats Friction and Coil Heat



ENLARGED SECTION OF PILOT CARTRIDGE

To Achieve Endurance, a Breakthrough in Speed

Generally, the most unpredictable factor in solenoid valve life is the solenoid coil itself, and yet, a solenoid can be made to last practically forever if the coil can be kept from overheating. Coil heat is generated by long plunger travel and accelerated by erratic drag (friction) during that travel. Achieve a short, quick, sure plunger stroke and the coil will last indefinitely. Therefore, the life of a solenoid pilot air valve is directly related to speed of operation. To achieve operating speed, friction in the pilot section and solenoid plunger travel must be reduced to a minimum. Solve these problems and you get air control reliability that seems to have no limit.

The Call-Outs Tell the Story of Endurance

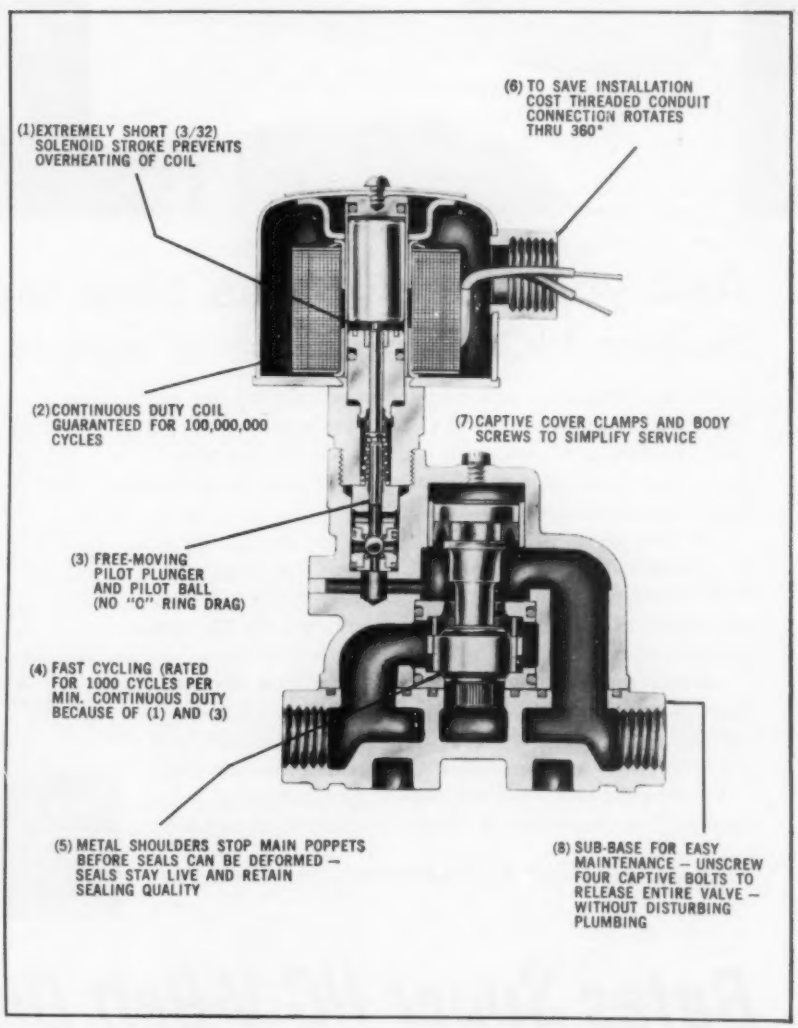
To control the major source of coil burnout, coil heating, the stroke of the solenoid plunger must be reduced to a minimum. The short stroke fractions the time the coil is energized; heat generation drops and response time of the valve is stepped up. In the "Mach 2" the stroke has been reduced to 3/32—about the thickness of a nickel. Furthermore, the friction problem must be solved, to avoid any unpredictable drag. In the "Mach 2" this has been done by use of a pilot cartridge enclosing a free-moving ball that seats on "O" rings at both ends of the cartridge [see above]. The ball moves freely, independent of the seals. There is no "O" ring drag on the pilot plunger as it requires no seals. When there is no friction there is no wear. Similarly, the main valve seats seal on "O" rings. In the sealed position, metal shoulders take the shock in such a way that the "O" ring seal is merely kissed by the main valve seat [see (5) below]. As the rings are only minutely flexed they do not fatigue or lose their resilience.

What about Cycling Speed?

Short solenoid plunger stroke and elimination of friction make extremely fast cycling feasible. After exhaustive testing in the laboratory and on industrial applications for over six years the "Mach 2" is rated at 1000 cycles per minute continuous duty. Cycling speeds as high as 2100 have been successfully reached for intermittent periods of twenty minutes. During a two-hour test at a sustained speed of over 1500 cycles per minute the coil temperature stabilized at 7°C below the maximum code limit for Class A coils.

100-Million-Cycle Guarantee on Solenoid Coils

The design advances incorporated in the CRESCENT® "Mach 2" Air Valve are a significant breakthrough in both cycling speed and operating dependability. Put CRESCENT® "Mach 2's" (¼- to ¾-inch pipe sizes) on your "valve killer" jobs and see how freedom from coil burnout helps to cut operating costs. Write for an advance copy of the new CRESCENT® "Mach 2" catalog to Barksdale Valves, 5125 Alcoa Avenue, Los Angeles 58, Calif.


(1) EXTREMELY SHORT (3/32) SOLENOID STROKE PREVENTS OVERHEATING OF COIL
(2) CONTINUOUS DUTY COIL GUARANTEED FOR 100,000,000 CYCLES
(3) FREE-MOVING PILOT PLUNGER AND PILOT BALL (NO "O" RING DRAG)
(4) FAST CYCLING (RATED FOR 1000 CYCLES PER MIN. CONTINUOUS DUTY BECAUSE OF (1) AND (3)
(5) METAL SHOULDERS STOP MAIN POPPETS BEFORE SEALS CAN BE DEFORMED — SEALS STAY LIVE AND RETAIN SEALING QUALITY
(6) TO SAVE INSTALLATION COST THREADED CONDUIT CONNECTION ROTATES THRU 360°
(7) CAPTIVE COVER CLAMPS AND BODY SCREWS TO SIMPLIFY SERVICE
(8) SUB-BASE FOR EASY MAINTENANCE — UNSCREW FOUR CAPTIVE BOLTS TO RELEASE ENTIRE VALVE — WITHOUT DISTURBING PLUMBING

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WHAT'S HAPPENING IN RESEARCH . . .

Simplified route to high vacuum

A method for attaining ultrahigh vacuums without system bake-out was reported by Lawrence Radiation Laboratory researchers to the American Physical Society's recent West Coast meeting.

The technique uses molybdenum as a "getter."

After the system has been exhausted to the 10^{-7} mm Hg range by standard techniques, the molybdenum is brought into play by continuous evaporation of the metal from simple, hairpin-type filaments. This, the researchers say, brings the pressure down below 10^{-9} and holds it there. In an 85-liter system, for instance, only 0.3 gm of metal was needed to maintain that level for 40 hours.

Conductive organics show unusual properties

Organic compounds with the "largest electrical conductivity yet reported" are described by DuPont researchers in a letter to the *Physical Review*. These are quinolinium (TCNQ) salts which show a temperature-*independent* paramagnetism, and appear to offer "a unique opportunity for experimental study of electronic conduction and interaction."

Conductivity of one compound ranges as high as 100/ohm-cm, while that of another is 4/ohm-cm (in the direction of highest conductivity). A wide range of solids containing the TCNQ radical is now under test, and additional reports will be prepared.

Three guideposts for thermoelectrics

Electrode compatibility, contact resistance, and output stability under operating conditions are three of the most basic problems of thermoelectric power conversion, says J. M. Epstein of the Martin Co in a report prepared for the joint Technical Society–Department of Defense Symposium on Thermoelectric Energy Conversion. Until these problems are solved, there will be severe limitations on efficient utilization and application of thermoelectric materials.

A good start is being made, though, in determining the factors which influence these properties. For instance, substitution of Armco iron electrodes for nickel with lead telluride couples brings a 6-fold improvement in performance. The reason: nickel migrates into the semiconductor; the iron does not. In 50 hr of operation at 930 F, says Epstein, the output from nickel-faced electrodes dropped 62%, while the drop in output when iron-faced electrodes were used was little more than 10%.

Similar studies are being made of the other two characteristics, and predictions are now that it will be possible to design thermoelectric units with outputs on the order of 25 kw/lb.

briefs . . .

Copper's ultimate yield strength under tension is "in excess of 100 kilobars (almost 1½ million psi)," R. G. McQueen and S. P. Marsh of Los Alamos Scientific Laboratory report. At LASL, copper specimens have been subjected to large tensile stresses by colliding explosive-driven plates, producing shock waves up to 600 kb that propagate in both directions from the impact interface. Interaction of rarefaction waves so produced creates the tension that strains the metal.

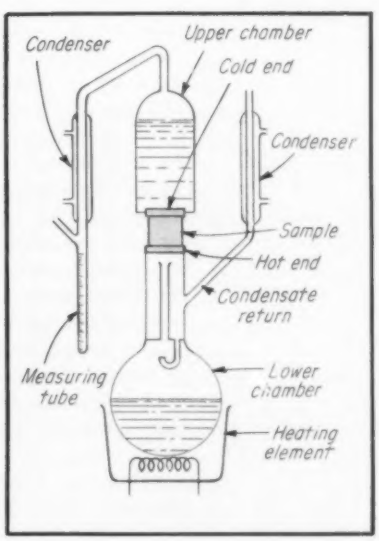
Resistivity of metal wires increases as wire diameter decreases, F. J. Blatt and H. G. Satz told the American Physical Society. Tests at Michigan State U confirm previous studies, made with thin indium wires, and indicate that both the residual and the temperature-dependent resistivity are affected. –ARG

Heat-conductivity measurement made easy

A stopwatch technique that measures thermal conductivity of solids without temperature or quantitative heat measurements is reported by J. Schroeder of the Central Research Laboratory of Philips Industries of Germany (Aachen).

A small cylindrical sample (less than ½ in. dia and about ½ in. long) is mounted in contact with two liquids of different boiling points so that the two ends of the sample are maintained at different temperatures (see diagram). Conductivity is then determined by measuring the time in which, in the steady state, a specific quantity of heat passes through the sample. This quantity is, in turn, indicated by the amount of liquid evaporated at the "cold" end of the sample. Temperature differential between the two ends is about 20 F.

Equations for calculating the thermal conductivity on the basis of sample dimensions, liquid volume, and boiling points have been worked out, and calibration curves have been plotted. The determination takes less than 15 min; and, Schroeder says, the error is less than 3%.



DIFFERENTIAL BOILING RATES maintain ends of sample at different temperatures, permit determination of thermal conductivity on the basis of time it takes for heat transmitted through sample from lower, hotter end, to evaporate a specific amount (measured in tube at left) of lower-boiling liquid in upper container. Silver plates at hot and cold ends of sample ensure good thermal contact.

DEVELOPMENTS TO WATCH...

Photocell relay developed for high-voltage use

On high-voltage circuits where insulation of electromagnetic relays becomes a serious problem, the United Kingdom Atomic Energy Authority is now using a photocell system developed by its engineers.

A neon glow-discharge tube is connected to the circuit being monitored in such a way that the tube is energized when a fault develops. Then, light from the tube actuates the photocell, bringing in a low-voltage relay which sounds the alarm. The tube itself is housed in a plastic case that excludes extraneous light and provides a well-defined light beam; and, for ultrahigh-voltage circuits, where the distance between neon tube and photocell must be substantial, an acrylic plastic light-guide "pipes" the beam from tube to cell. The system is now being licensed for commercial production.

Micro motors, made of plastic, promised by Soviet engineers

Motors and transformers of high efficiency and small size are being developed, the Soviet News Agency reports, using plastics incorporating magnetic particles (see p 65).

The fact that these magnetic plastics are good insulators as well as good magnets, the Soviets say, brings design characteristics "close to the ideal theoretical level."

With "practically all" surface and pulsation losses eliminated, they claim, it is possible to increase motor capacity substantially while decreasing size and weight.

Sintering in glass bath: cheaper route to powder-metal parts?

Powder-metal parts can be sintered faster and at less cost by immersing them in molten glass, says D. Yarnton of Rotherham College of Technology (Britain).

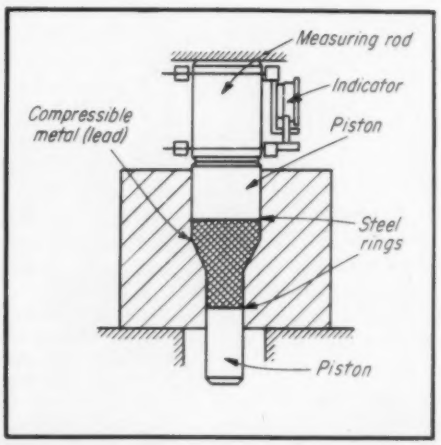
The molten glass serves not only to heat the parts but also to protect them from the surrounding atmosphere. Vacuum chambers are eliminated. Magnetic materials show no oxidation, and iron powder parts come out with a "brilliant, silvery finish." In some cases, the glass infiltrates the compact, forming a metal-glass case of high hardness, yet with surprising impact resistance.

The technique has so far been applied only to relatively simple sections, and mass-production techniques need further study—but work is continuing, to modify the process for more complex parts and adapt it for continuous production of strip.

Soviets replace hydraulic fluid with soft metal

A "hydraulic force-multiplier" in which solid metal is the pressure-transmitting "fluid" has been designed at the USSR Academy of Sciences. The unit has a 1000-ton capacity and a multiplication factor of 4, and is said to be adaptable for machine-tool use. The system has the advantage of permitting working pressure in the cylinder to approach the elastic limit of the cylinder itself. However, it is primarily a one-way system. Considerable back-pressure would be needed to restore the metal to its original condition.

The prototype model is conventional in outline, but steel packing rings are used; and piston fit is very loose, to prevent jamming. Lead is the hydraulic metal, chosen, says a report in *Inzhernernofizicheskiy*, because it provides high efficiency (about 86%) at low cost.

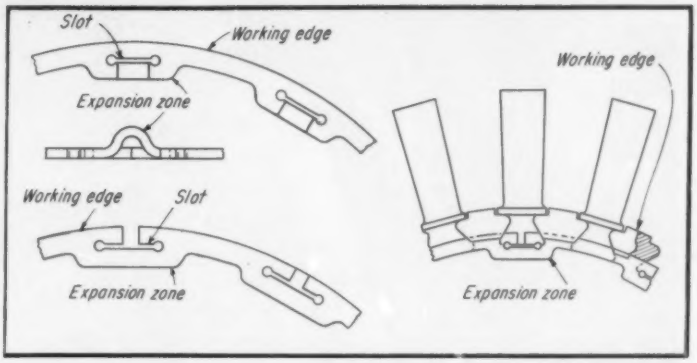


HIGH-PRESSURE RAM, with lead as the hydraulic medium, is equipped here with measuring rod and dial indicator for test.

Retaining ring is assembled without spring action

A retaining ring that is rigid, yet offers the advantages of spring-type components, is claimed by a Canadian inventor.

Instead of building the unit of spring steel, the design provides annularly spaced expansion zones that lock the ring into position; and the material used is mild steel, carefully chosen so that it does *not* have spring action. The primary aim: to provide a retaining ring serviceable under high-temperature conditions (as in jet engines) and under severe nuclear irradiation —conditions that make spring steel lose its temper or fail by thermal fatigue.



WORKING EDGE of rigid retaining ring is forced outward in the "expanded" condition, when deformable sections are all hammered into the main plane. When deformable sections are axially displaced, working edge is contracted. Cross-section diagram (above, left), shows element in "contracted" position. Diagram at right shows application to a turbine rotor.

Information on the device (#2802) may be obtained from Canadian Patents & Developments Ltd, National Research Bldg, Sussex Drive, Ottawa.

New glasses and metals from old semiconductor

Germanium–gold alloys with the relatively unusual property of expanding when they freeze, and a germanium–gold eutectic with a remarkable low melting point–these are among the materials arousing interest outside the electronic field. The eutectic–12% Ge—melts at about 660 F, as compared to 1700 for Ge and 1946 F for Au.

There are other developments in germanium-bearing metals as well. When added to such nonferrous metals as copper, aluminum, and magnesium, germanium has a noticeable hardening effect, F. L. Fisher of the Bureau of Mines points out. Germanium also improves the rolling properties of these metals.

In glass, germanium dioxide, as a full or partial replacement for silicon dioxide, produces lens materials with unusually high indices of reflection. And magnesium–germanium glasses have unusual infrared properties.

It looks as though germanium will be worth watching even if its semiconductor uses decline.

New way to fabricate thermoelectric elements

Rotary swaging can produce tubular thermoelectric elements of high power density and compactness at moderate cost, Westinghouse Atomic Power Dept researchers report. And, because the elements are completely encapsulated, they should show high reliability and long service life. Tests of several tellurides (lead, germanium, bismuth-germanium) indicate the process can be applied to quite a few materials, and a variety of sizes can be produced.

Electrical resistivity, Seebeck coefficient and thermal conductivity over a wide range of temperatures "compare very favorably" with published data for cast and pressed-and-sintered thermoelectric materials of similar composition, J. C. Danko of Westinghouse told the joint Technical Society–Dept of Defense Symposium on Thermoelectric Power Generation.

As cladding materials, for lead telluride, low-carbon steel, Type 304 stainless, and ferritic stainless, all seem satisfactory, and tungsten appears compatible with germanium-bismuth telluride.

A six-couple thermoelement produced by rotary swaging (using n- and p-type lead telluride washers and machined insulators) is now being instrumented for laboratory bench testing.

(Note: For more on swaging as a means for producing tubular parts, see *PE*—Dec 1 '58, *p* 5; and for more on thermoelectrics, see *p* 7.) —ARG

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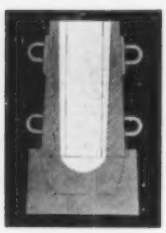

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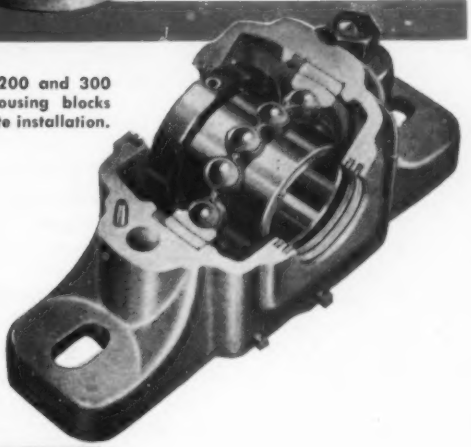

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FROM WASHINGTON . . .

Our space program slated for overhauling

The nation's space program will get a thorough reassessment by the Kennedy Administration. **The new President's first step will be to reinstate the National Aeronautics and Space Council.**

Membership of this council includes the Secretary of State, Secretary of Defense, NASA administrator, chairman of the Atomic Energy Commission, one member from any government agency to be named by the President, plus three members from industry who are scientists or engineers.

Congress, at the insistence of the Senate and specifically Sen Lyndon Johnson, established this top-level, 8-man council to advise the White House on the nation's space program. Eisenhower, however, never used the council; in fact, it met only once or twice. Nor was the 4-man staff provided by Congress for the council ever appointed.

One of the first things the new council will do is review the space budget for fiscal 1962. Reportedly this will climb from this year's $1.3 billion to around $2.0 billion for next fiscal year and up to $5 billion by 1965. The council, however, will be under pressure to take a hard look at where the money is to go, and probably recommend a shift of funds rather than an increase in the total.

Once the council has made a complete reassessment of the space program, it may recommend supplemental budget requests to Congress if more money is needed.

However, putting all-out space program under one head is not likely. **Reportedly, the Kennedy Administration still plans to keep both military and civilian space programs.** But the council will take a hard look at what NASA and the other military services are doing.

Overlaps in effort will be consolidated under either one or the other; this was the original intent of Congress when it voted the National Aeronautics and Space Act of 1958. But today there is still wide duplication in space programs. For example, both the military and NASA have satellite-communication programs, booster-development programs, and many others.

Major question the new council will take on early is what role the government should play in commercial space projects. Industry is pushing for decisions. One key decision needed is microwave-frequency assignments for space use by the Federal Communications Commission. Others include who the government will allow to put up a satellite, how much cost the government will bear, etc.

US seeks satellite orbit-control systems

Keeping satellites in precise orbit once they have been put there is a problem facing the space experts. **The fast advance into communication satellites, primarily, is forcing engineers to come up with satellite orbit-control systems.** All satellites gradually fall out of orbit. But for a multimillion-dollar satellite-communication system to pay off, it must be kept pretty much where it belongs.

The problem varies with the active satellites that are laden with receiving, storing, and transmitting equipment and the passive reflector satellites that carry no equipment. Weight is the key factor. Mainly this is for fuel that must last the life of the satellite to power control systems. This ranges all the way from only three to five years up to 10 to 20 years for some systems being proposed. By 1962 NASA plans to have one active communications satellite in orbit. In 1963, it plans to have 20 passive satellites in orbit to form a world-wide communications network.

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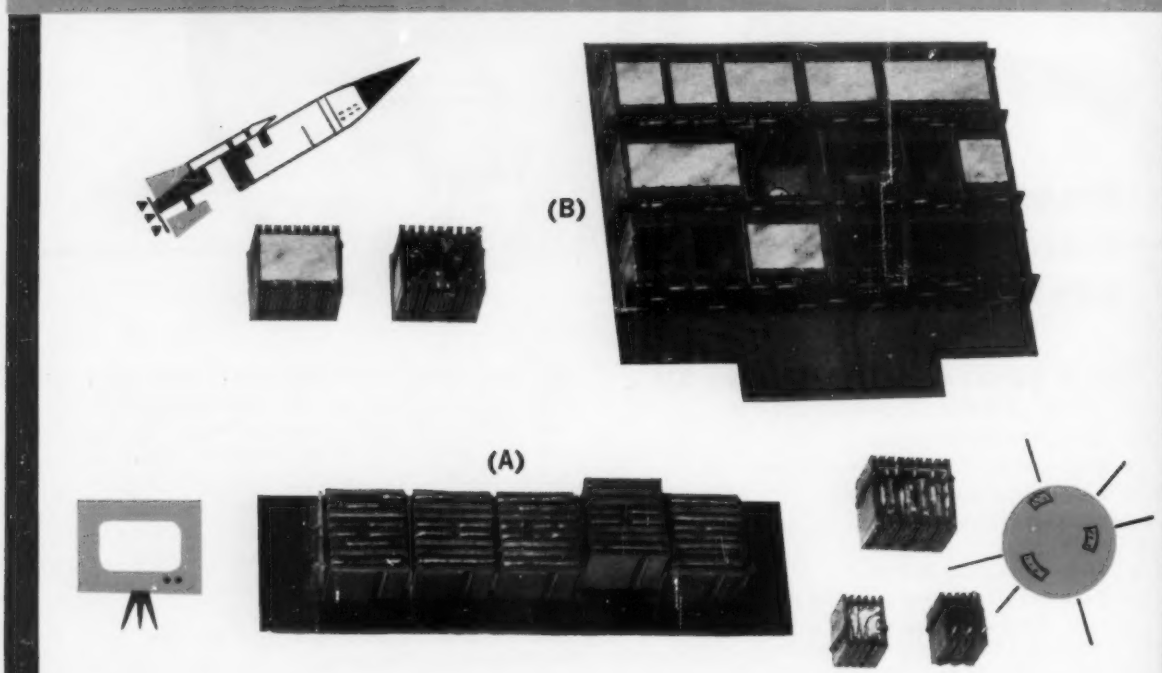

Shown above (A) series, and (B) parallel circuits.

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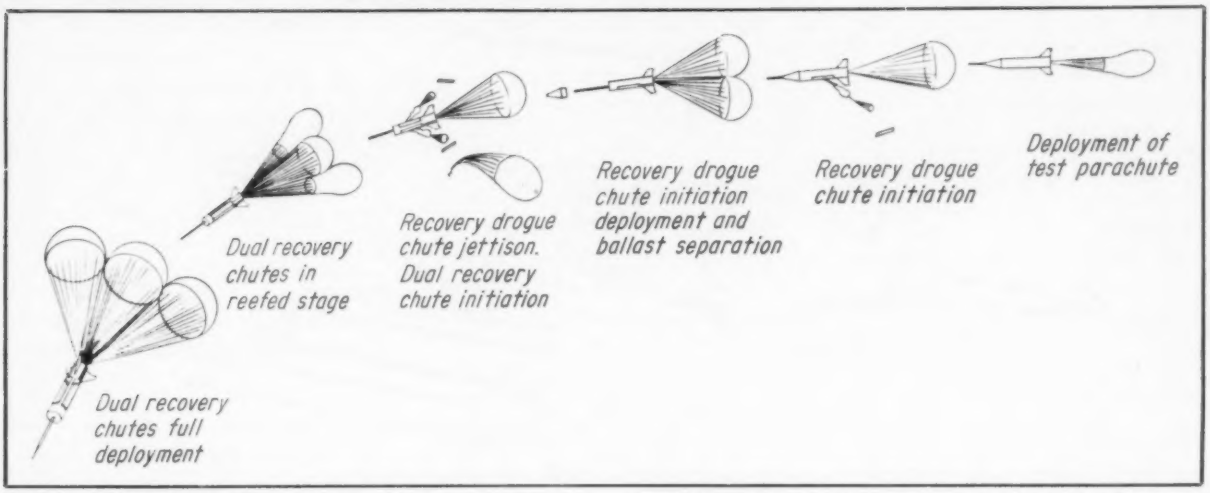
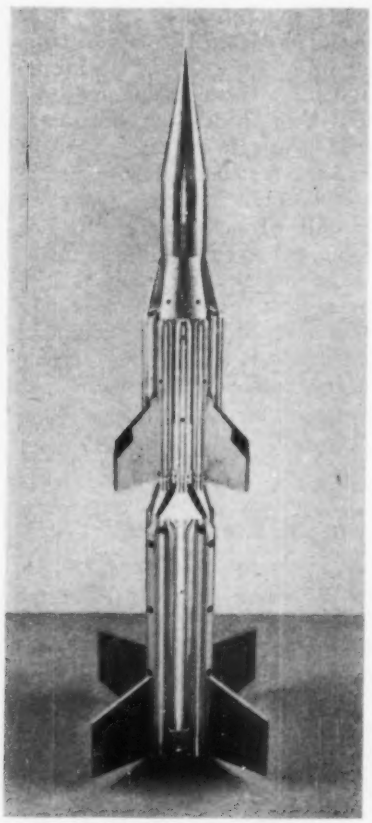
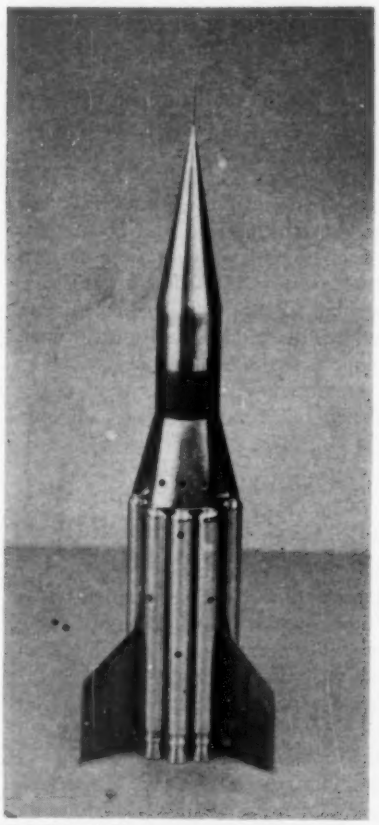
THE ENGINEERING WEEK


Dual recovery chutes full deployment
Dual recovery chutes in reefed stage
Recovery drogue chute jettison. Dual recovery chute initiation
Recovery drogue chute initiation deployment and ballast separation
Recovery drogue chute initiation
Deployment of test parachute

FLIGHT SEQUENCE shows operation of test device and recovery equipment. Each parachute has a pilot chute to forcefully eject and deploy the main chute from its compartment. Each stage of recovery is independent.

Variable Vehicle to Test Mach-3 Recoveries at Altitudes to 80,000 ft





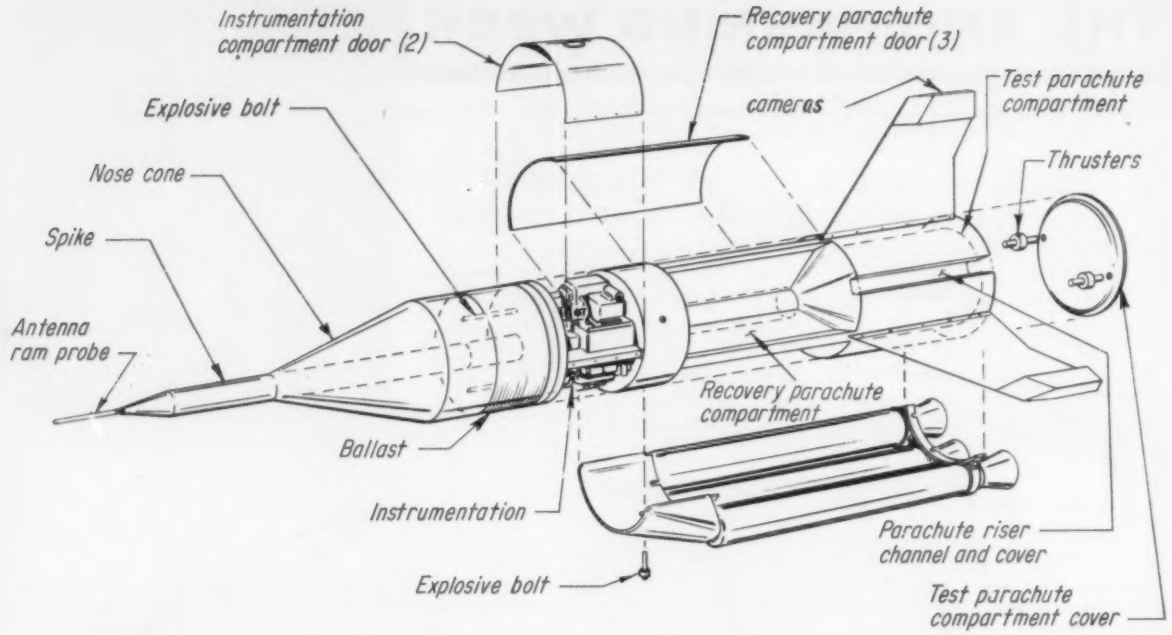
WIND TUNNEL model shows two-stage vehicle (above) with four Terrier and nine Javelin boosters; and second-stage alone (right). Terriers are bolted to a main support at the front end which acts as alignment and thrust structure to transmit first-stage thrust to aft end of test body. This supporting structure is secured to the test body by four explosive bolts. Pyrotechnic thrusters mounted within the thrust structure force separation.

Los Angeles—Versatility is the important ingredient being designed into one of Uncle Sam's newest test vehicles. It's called for in the configuration design contract, for a Mach 3 chute vehicle, awarded to the Coleman Engineering Co, Torrance, Calif. The rocket can be air- or ground-launched and easily modified to suit changing test requirements. Its use: to test recovery devices between Mach 1.5 and 3.0 at altitudes between 5000 and 80,000 ft.

The two-stage configuration permits, for example, the first stage to be altered for two or four Terrier or equivalent rocket engines and to be coupled with three, six or nine Javelin or equivalent rockets in the second stage. Rockets can be fired in pairs or salvo depending on the test. For some tests, the first stage may be eliminated entirely.

The configuration, designated the Supersonic III Test Vehicle, will be used to test many types of recovery equipment; chutes of various designs; balloons and other devices. Normal sequence of a test program visualizes the first stage boosting the entire vehicle to some predetermined altitude and velocity. At a programed time interval after the first stage is jettisoned, the second-stage Javelins are fired.

The test device is projected from



TEST BODY is compartmented for electronic gear, ballast, test device, and recovery equipment. Three fin-mounted high-speed cameras record recovery and stage separation. Cameras are adjustable to cover a range of frame speeds from less than 32 fps to more than 1000 fps. By varying the mounting surface angle, field of view can cover close or far subjects either forward or aft.

the afterportion of the vehicle while it is still on an upward trajectory. Cameras mounted in the vehicle's fins record the test and telemetry instrumentation, send pertinent data to ground stations. As the vehicle slows down and arches over, a 6-ft drag chute opens, followed by three 20-ft recovery chutes. Nonexpendable instruments and the basic airframe are recoverable.

TEST BODY

Minimum weight of the test body is 2000 lb. This can be adjusted in 100-lb increments to 5000 lb maximum. At max weight, a max velocity of Mach 3.0 up to about 55,000 ft is attainable; or Mach 2.3 at 80,000 ft. Mach 3.0 at 80,000 ft can be achieved with any vehicle weight up to 4000 lb.

Over-all length of the test body is about 260 in. (including spike and antenna of 45 in.) and top dia is 25 in. For ease of design and fabrication, the test body is divided into two sections; forward section of impact spike, nosecone fairing and ballast section, and aft section of instrumentation compartment, parachute compartments and fin assembly.

Test body is primarily constructed of welded steel. The pointed steel spike extends through the ballast section and ties to the main assembly joint between the ballast and instrumentation sections. From this point back to the forward end of the test parachute compartment, a heavy steel tube forms the primary structural backbone of the vehicle. To this are welded the circular bulkheads which support the skins and also serve as compartment dividers.

The program, which was initiated in August of 1960, is scheduled to be completed within approximately 18 months from the start. The dollar value of phases I & II is in the magnitude of $200,000. Phase I—theoretical design and wind-tunnel tests of a scaled-down model—has been completed. Phase II will encompass the detail and the building and testing of one "boiler-plate" drop-test prototype. Phase III will include the construction of one ground-fired prototype of the approved design. Discussion is underway to include four working vehicles in the final phase within an additional contractual award. Entire program will then cost about $600,000.

—William B Wallace, Regional Editor

Improved Computer Designs Shown at Conference

NEW YORK—Nearly every major manufacturer of computers and computer equipment was on hand for the exhibit accompanying the Eastern Joint Computer Conference here. A number of manufacturers chose this time to announce new equipment and developments. Among the new arrivals these four seemed significant:

1. A low-priced desk-size computer from Autonetics Div, North American Aviation Inc., Recomp III is a less sophisticated and less powerful version of the company's two-year old Recomp II (*PE*—Apr 11 '60, p 43). The new model shares many of the features of its predecessor (completely transistorized, 4096-word memory), but lacks the built-in floating point, the tape reader or many of the other input/output control and verifying functions. Recomp III will rent for approximately $1495 per month, sell for about $65,000. This compares with the newly announced (effective, Jan 1) Recomp II figures of $2495 and $95,000. An additional $500 per month will add floating-point hard-

ware to the Recomp III, and in this form the machine is roughly equivalent to a Recomp II without control console or tape reader. It is intended as a production machine for running calculations from previously prepared programs.

2. A battery power supply for the recently announced (April '60) Packard Bell, PB 250, desk-size computer. Portability is not the aim of Packard Bell engineers—users still have to stay close to 115-v lines. Chief job of the battery is protection against power failure. The battery, placed where it is between the computer and a trickle charger connected to the 115-v line, serves to safeguard the data stored in the PB 250's volatile, magnetostrictive-delay-line memory, and to filter out power-line noise and voltage variations, which can affect circuitry operation. With the battery in the circuit, the machine can be operated from even poorly regulated mobile generators. The battery delivers the +6 and −12 v dc for the logic circuits, and has sufficient storage capacity to drive it for periods up to one hour. However, typewriter input, tape reader and indicator lights still require a 115-v source. The battery is good for about five years without service, say PB engineers.

3. A computer-controlled teaching machine that is potentially more versatile than mechanical and electromechanical tutors now available (*PE—Oct 3 '60, p 48*). The new teaching aid is a joint effort of System Development Corp and Bendix Corp. Heart of the system is the Bendix G-15 general-purpose computer, which can store enough tutorial material to meet the needs of both slow and fast learners, and serve as many as 100 students simultaneously. Though the present model is only a research device, its developers foresee a schoolroom of the future in which students communicate with a central computer by means of a slide projector and keyboard at their desks.

4. A thin-film magnetic memory with switching time almost 1000 times faster than previous memory devices, announced by Remington Rand Univac Div of Sperry Rand Corp. IBM recently announced development of their thin-film memory plane, based on cryotrons (*PE—Dec 26 '60, p 19*). The new Univac memory consists of a series of metal dots made by depositing vapors of iron, nickel, cobalt and other ferromagnetic materials on a nonmagnetic substrate such as a thin glass plate, and serves as the nerve center in Univac's new 1107 computer, a third-generation machine suitable for either scientific or business applications.

—C J Lynch

Italy Takes a Second Look At the Computer Market

MILAN—Industry in Northern Italy is taking another look at computers. Long wary of the Italian machines because of their low quality and of computers in general because of personnel-training problems, many companies are reevaluating computers and some, like Montecatini and ENI here, are experimenting with data-loggers in their plants. One firm, CEA-Perego, has even started to make data-loggers and has installed a few in power and chemical plants. This company is also working on a digital computer for the process industry.

Up to now, no general-purpose analog computers have been made in Italy; these are usually supplied by the US. But this may soon change as CEA-Perego and the National Nuclear Research Committee (CNRN) develop computer hardware. Both of these organizations have designed operational amplifiers, and CEA-Perego makes servo-amplifiers and servo-multipliers.

On the other hand, fire-control analog equipment for military purposes is big business. Contraves Italiana (subsidiary of a Swiss firm), Nuova San Giorgio of Genoa, Galileo of Florence, and CEA-Perego are all working on fixed-program computers for this purpose.

Most of the new knowledge is coming from US and British consulting firms that are showing the Italians—and at the same time teaching them—the economies of computer-operated plants. In fact, SNAM Progetti of the ENI group—state-owned oil and gas agency—is designing and building highly automated chemical and refining plants in several parts of the world.

—Gene Di Raimondo, Regional Editor

USSR Urges Trade on UK, Soviet-style

Moscow—British businessmen are trying to increase exports to the USSR, and the Soviets are egging them on. However, it appears that economic and political realities rule out any immediate results.

For one thing, Lord Boyd Orr, president of the British Council for the Promotion of International Trade, recently urged that various steps be taken such as easing credit arrangements and trade restrictions to promote greater trade with Communist countries.

USSR OFFICIAL SPEAKS

For another, a key Soviet Foreign Trade Ministry official has said the USSR wants to sell, as well as buy, machine tools in Britain, and is hoping for substantial 2-way trade between the two countries, *The Financial Times* reported from London. The paper quoted Ivan Timofeiev, chief of the Stankoimport (Machine Tools Import) Dept of the Foreign Trade Ministry, as saying: "To live we must breathe out as well as breathe in . . . it will never spoil business if we have a good turnover of machine tools between our two countries."

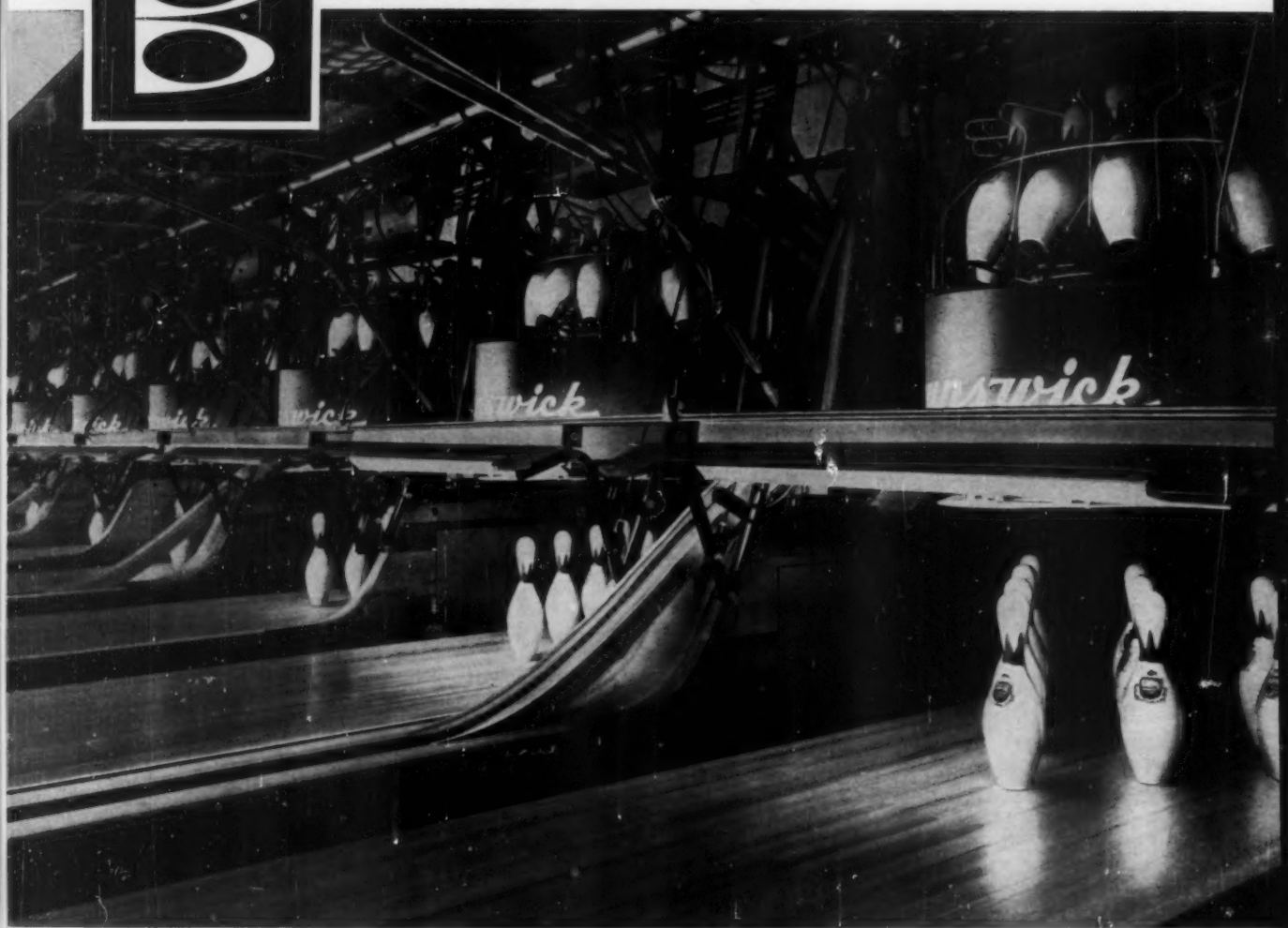
Timofeiev claimed anxiety expressed by British firms over Soviet competition was unfounded, but agreed his department was very interested in foreign markets, including Britain. He further revealed that his department had signed contracts worth "several millions of dollars" for the purchase of machine tools in the US in the past few months and felt this was "only the beginning" of renewed Soviet-American trade.

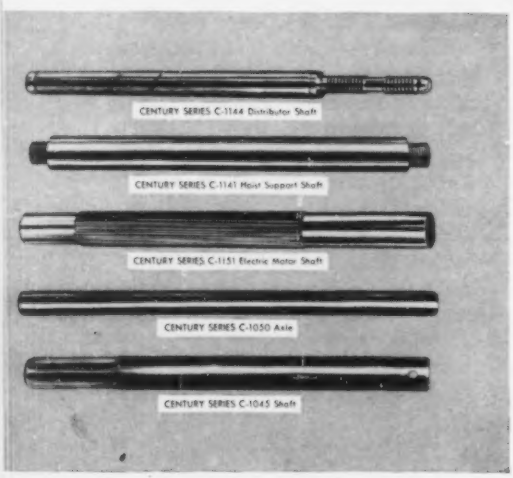
He expressed high hopes, however, that the exchange of British and Soviet commercial exhibitions next year would give a big boost to Anglo-Soviet trade in machine tools as well. Timofeiev was referring to a $1.4-million contract recently signed with the David Brown Corp Ltd, for gear-cutting machine tools and said he was confident that inquires made to other British companies would lead to more contracts.

Asked whether Soviet machine tools

Continued on page 20

Brunswick CORPORATION puts "Mechanical Brain" to work

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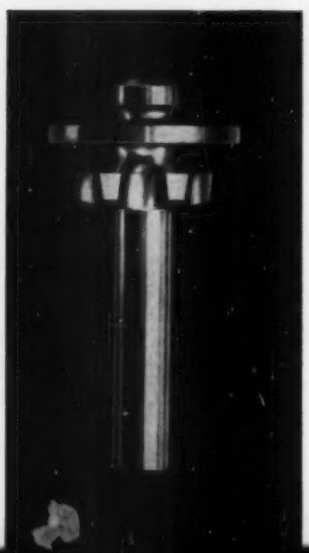

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Republic, world's largest producer of specialty welded tubing, offers ELECTRUNITE in a wide range of sizes, gages, and wall thicknesses, supported by technical and metallurgical assistance. Prompt price and delivery quotations usually within twenty-four hours. Call your Republic representative. Or, write direct. Use coupon below.

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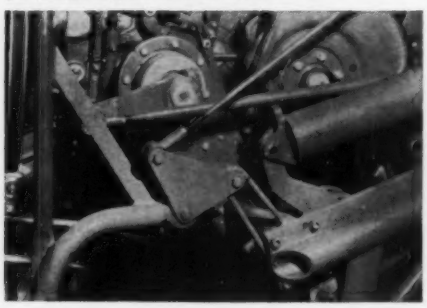
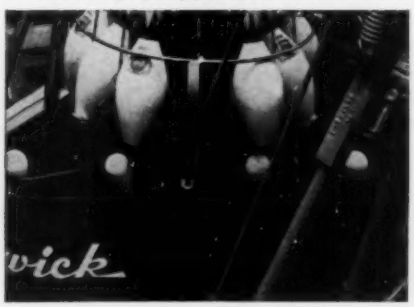
When the ball hits the hinged pit cushion the motion is mechanically transferred to trigger the machine cycle. ELECTRUNITE Mechanical Tubing is used for the pit cushion support arms construction.



ELECTRUNITE Tubing in three key locations assures smooth, trouble-free lifting, sweeping, Automatic Pinsetter operation. ELECTRUNITE is delivered ready for fabricating, saving production time and costs.



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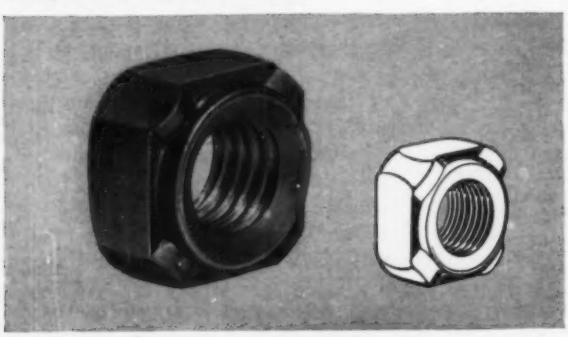

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continued from page 17

were exported at a profit based on production costs at the new ruble-exchange rate, he replied: "The way our industry is set up now we can make good profits from machine-tool exports at world market prices."

And then, the daily economic publication of the Soviet Communist Party, *Ekonomicheskaya Gazeta*, says it has a letter from John Scott, commercial director of Crompton Parkinson Ltd, a British firm. Scott is reported as pointing out British business interests in Anglo-Soviet trade as reflected in the fact that 550 firms now belong to the Russian-English Trade Chamber, and that a recent booklet by the London Trade Chamber on economic relations with the Soviet Union sold out during the first week.

The *Gazeta* said Scott mentioned Soviet-Anglo trade which now runs to some 100 million pounds sterling could be doubled by 1964 if certain obstacles were removed. These included: NATO strategic embargo on the British side, and limited sterling on the Soviet side. Also mentioned were delays by Soviet organizations in answering mail, British fear for patent protection in USSR, reluctance of Soviets to cite specifications, terms and prices on the Soviet machinery they're trying to sell, and Soviet insistance on maintaining control over shipping in both directions. In the past British manufacturers have been forced to pay high storage charges beyond contract terms while awaiting the arrival of Soviet ships.

In a story accompanying Scott's letter, the *Gazeta* predictably attacked European trade blocs and painted a picture of a Soviet Union anxious to trade goods with Britain.

However, *Ekonomicheskaya Gazeta* skirted most of the questions raised by Scott.

For example, on the question of raising the sterling balance for the purchase of British goods, the *Gazeta* plumped hard for sales of Soviet oil—ignoring the fact that British imports come mostly from British holdings in the Middle East and Venezuela, countries which would resent the market loss.

The Soviet paper blandly shrugged off the question of patent protection, asserting that Soviet law protects the foreigners' patents.

Soviet charges that NATO restrictions prevent British businessmen from finding markets for goods, and that armament spending holds down export potential, are related to the Soviet campaign against locating the Polaris missile base in England and against Britain's military alliance with the US. ■

Tri-jet Airliner Designed for Short Range

The 727, Boeing's new addition to its family of jets, will carry from 70 to 114 passengers at speeds up to 600 mph over distances ranging from 150 to 1700 mi. Picture shows final configuration. Also studied were the three engines mounted around a vee (butterfly) tail, and around a twin tail; and one which placed two engines in wing pods, with the third in the tail. Boeing's 727 is about the same size as the latest American turbo-props. Its fuselage width of 12 ft 4 in. equals that of the 707, but is 24 ft 6 in. shorter, and its 108-ft wingspan is considerably less than the 130 ft of the 707. A three-engine airliner can operate under lower visibility and ceiling limitations than twin-engine aircraft. A statistical analysis showed that operating from New York, a twin-engine craft can be expected to be delayed by weather more than 3 times as often as a 3- or 4-engined plane.

NSPE Finds Engineers Lack Full Professional Status

WASHINGTON—Is it important for engineers in industry to be recognized as professionals? And, if so, who is responsible for improving the present status of engineers? These questions were put to a cross-section of executives and technical men between April and August last year by the National Society of Professional Engineers. The questions evoked fairly wide agreement on what should be, but somewhat less agreement on what is.

Both management and engineers agree that technical personnel should have a thoroughly accepted professional status within the company. But only 26% of the surveyed engineers say that their companies actually regard them as professionals. This contrasts sharply with the managers—56% of whom say they hold engineers in very high professional repute.

In either case, there is wide room for improvement. Hence, the survey gave considerable attention to fixing responsibility for raising engineers' professional status. Both engineers and managers overwhelmingly concur that it's imperative for engineers to develop their communications skills.

Some 73% of the engineers queried say that they are now working on this problem. But their efforts have apparently not yet penetrated management's consciousness, for only 22% of the executives see progress.

Again there is overwhelming agreement between the two groups that

management's prime responsibility is to pay salaries fully reflecting engineers' contributions. But relatively few engineers—only 23%—feel that salary progressions match their contributions. As for the executives, 73% say that companies are now paying fairly.

Engineers have other responsibilities for improving their professional status, the NSPE finds. A large proportion of both executives and technical men agree that engineers should try to learn more about the business objectives of their projects and also learn to use channels of communication with management.

Again, the engineers see considerably more progress than management. The survey finds that 73% of engineers believe they are attempting to understand the business objectives and 60% say they, indeed, are trying to use communications channels. Only 33% of the executives say that engineers are showing improvement in these two areas.

As for management's responsibilities, engineers say that the company's executives must take some of the burden: encourage engineers to find out how their work fits into the entire project, and also see that engineers get varied and challenging work. Management says its major responsibilities (aside from salaries) are to treat engineers as individuals and keep them informed of company objectives and policies.

The problem of defining professionalism was also raised in the survey. Both engineers and managers concur that technical competence as shown by high standards of learning and skill are the distinguishing marks of the professional. Engineers say that a profession must also have prestige within the community, and about 12% say that their profession should establish standards similar to the Bar Association or the AMA.

Managers rank a high standard of ethics second to competence and an attitude of individual responsibility third. Only 5% of managers thought engineers needed standards similar to AMA to promote their professional recognition.

The survey was based on 350 interviews made by the Opinion Research Corp of Princeton. The six industries represented were electronics, aircraft, electrical instruments and machinery, chemicals, petroleum and rubber. ■

R & D Spurt Expected to Follow OEEC Reorganization

PARIS—A thoroughgoing reorganization of the 12-year-old Organization for European Economic Cooperation (OEEC) is in the offing. Barring unforeseen delays, a new body, to be known as the Organization for Economic Cooperation and Development (OECD), will be operating in its place by next fall.

The OECD is committed to much broader goals than its predecessor. Its stated aims are to build up underdeveloped countries and promote sound growth of member economies. These goals will probably be achieved in part by pressing for more R & D and closer coordination of national science policies. The OEEC was set up originally to rebuild Europe's economy after the war.

The shift in purpose largely results from US pressure, and the US, along with Canada, is expected to become a full member. These two countries have been only unofficial observers of the OEEC.

The new group will take over many projects started by the OEEC. Overall, technology is expected to receive somewhat greater emphasis than before.

One committee to be replaced in the reorganization is the European Productivity Agency (EPA). At its inception in 1953, EPA attempted to increase European productivity at the plant level primarily, by sending engineers and plant managers to the US to study production methods. Later, EPA shifted its emphasis to long-range technical-research and regional-development programs. Included in the technical research was a program for cooperative research in metal fatigue. These technical activities will be taken over next year by the Science and Research Committee of the OECD.

EPA's agenda during its last few months of existence is expected to produce some new approaches to cooperative R & D, which may emerge as Science and Research Committee projects. Final EPA sessions include a meeting in London, bringing together scientists and Parliament members; two seminars on the organization and administration of research; and a report of tax inducements offered by 21 countries to stimulate research.

OEEC's other semiautonomous unit, the European Nuclear Energy Agency, will continue under OECD. Although final decision is pending, the US is expected to become a full member of ENEA, rather than an associate member. Canada will remain an associate member.

OEEC's efforts to increase engineering and scientific manpower will be continued under the new organization, through a Scientific and Technical Personnel Committee. OECD will inherit a long-range program to improve science education in less-developed countries such as Portugal, Greece and Spain. One of these is a pilot project in Spain, directed toward attracting able young engineers and scientists into the field of teaching and research at new institutes of technology.

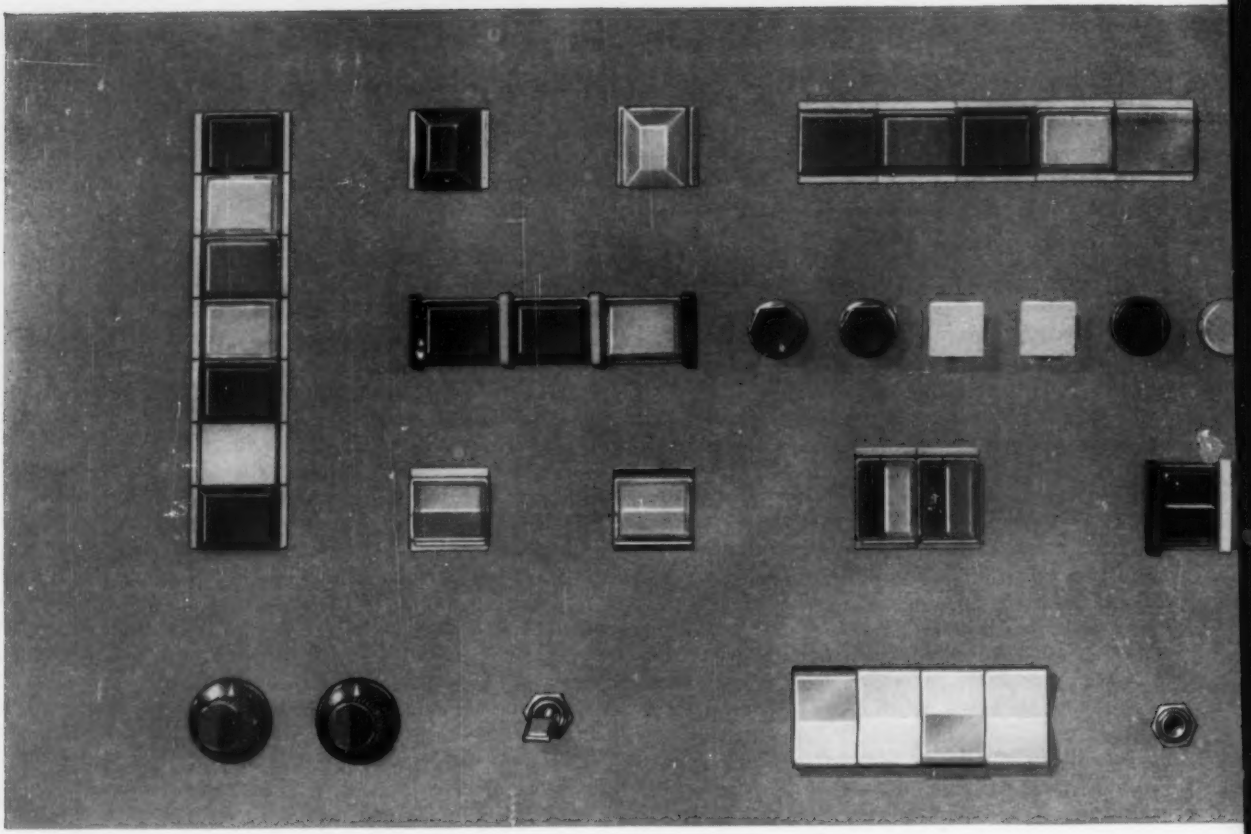
Another continuing manpower project will establish mobile science facilities for southern Italy, where schools have had trouble meeting the demands of industrial development. This and other existing manpower programs dovetail so neatly with the dual objectives of OECD that a source here predicts expansion of the science-manpower budget under the new organization. At present, manpower activities are budgeted at $1 million annually. They may rise to $1.5 million.

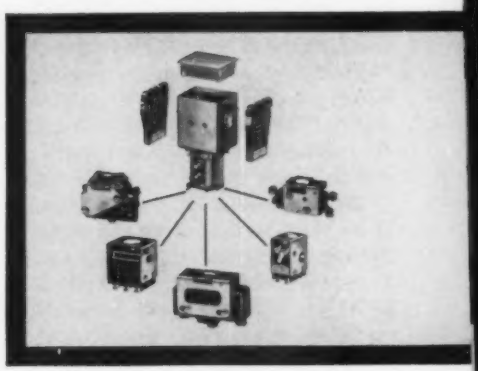
The fate of OEEC's machinery committee, which sponsored the famous Melman report and laid groundwork for a European machine-tool survey, is undecided.

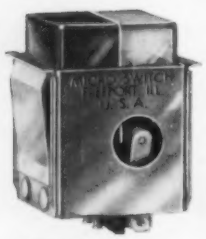
The new broadened goals of the European organization are a reflection of impressive operating success over the past 12 years. By working together, European countries achieved considerable prosperity and currencies that are strong enough to permit limited convertibility. European trade has been liberalized, so that today few import restrictions exist among European countries.

The broad outlines of the proposed OECD were hammered out during eight months of negotiations between the 18 OEEC members, the US and Canada. After being signed by foreign ministers of the 20 countries, 15 ratifications are needed to activate the organization. These are expected by fall of 1961.

—Arthur Erikson, Regional Editor







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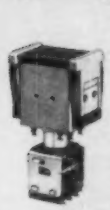

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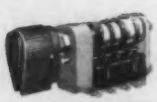

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POINTS OF VIEW

THE QUESTION:

What Technological Problems

Daniel E Noble
Exec vice-pres, Communications Semiconductor & Military Electronics Div
Motorola Inc

"Improvement of reliability . . .
is the most important single factor which may limit continued progress in the electronic field. Present techniques of increasing the complexity of circuits in order to achieve more mature results must result in steadily decreasing reliability. If we continue this trend without limit we shall ultimately reach the point where maximum complexity and zero reliability meet.

"The development of the transistor and semiconductor devices, in general, provided us with new dimensions for building complex devices with reasonable reliability. However, our demands for extended performance are increasing so rapidly that our need for complexity will soon outdistance the inherent capability of achieving acceptable reliability as we continue to make use of more and more interconnected components. Someday we must have, in a single monolithic circuit block, the equivalent of anywhere from a hundred to a thousand components. Solving the research, development, and production problems of these devices is vitally important to the communications industry. When one circuit monolith takes the place of a thousand components, this tiny, single unit will thus become the equivalent of a functional module. Several of these monolithic circuit structures can be combined to form larger modules. Maintenance will be a matter of checking whole-module functional structures, with repair achieved through the replacement of defective modules rather than by replacing defective components.

"It would be our wish that, with the development of the equivalent of a thousand-component functional circuit in a single monolithic structure, we could increase the complexity of future electronic systems a thousand-fold without decreasing the potential for reliability. This, at present, must be our hope for continuing progress in the electronics art."

"Expanded use of the radio-frequency spectrum . . .
is an essential requirement for meeting the demands of our ever increasing desire to communicate. Today we find that limited or wasteful use of available radio frequencies has created serious problems in electromagnetic compatibility. More simply stated—we're crowding too much into a small part of a large space. Not only is our national defense posture adversely affected, but also expansion of commercial interests in communication is retarded. Militarily we are feeling the pinch—particularly in telemetry, naval communications and radar, and army field communications. Commercially, television and aeronautical navigation aids, to name a few, are also faced with inadequate spectrum space. Two major solutions are open to us, and both depend on accelerated research and development:

1. More efficient use of radio frequencies would provide us with more channels per kilocycle. New modulation techniques which compress bandwidth are required in all forms of radio communication to alleviate objectionable interference.

2. Emphasis should be placed on experimentation at superhigh frequencies (above 3000 megacycles). Not only do we need to know more about the properties of radio waves at these frequencies, but also new components and equipment must be developed to make use of them.

"Unexpected benefits will surely appear as we learn more about little-used parts of the spectrum. Limited work has already indicated increased security and reliability of communication at frequencies approaching visible light. Still other superhigh frequencies appear to be ideal for piercing barriers formed by ionization or water vapor. Scatter or reflective techniques using natural or man-made reflectors will help to expand use of superhigh frequencies, but much component development aimed at reducing costs will be the real catalyst."

Frank A Glassow
Chief engineer, Electronics Astronics Div
Lear Inc

Need Solutions in the Communications Industry?

Maj Gen R T Nelson
Chief signal officer
Department of the Army

"There are literally hundreds of problems . . .
in the field of military communications-electronics which must be solved if the modern army is to be, in the words of Lt Gen Arthur Trudeau, Chief of Research and Development, 'as strong in the face of tomorrow's danger as it was on the battlefields of yesterday.'

"The US Army Signal Corps, which is responsible for Army communications, has defined many problems requiring solutions. In the area of command communications, for example, there is need for a lightweight, limited-range, two-way communication capability for squad use, a completely unattended radio transmitting station, and an antenna with the directivity necessary to discriminate against signals arriving from directions other than the desired one and capable of covering the entire high-frequency range.

"Also sought are microwave radio repeaters in support of satellite communication facilities, test equipment capable of quickly and accurately locating faults in field wire and cable, lightweight submarine cable for digital transmissions, and a capability to depict multiple targets and fixed-date information on displays for group viewing. Development of a global communications capability in the face of determined enemy electronic countermeasures is desired, as is development of an inertialess (nonrotating) scanning antenna with instantaneous acquisition, precision position control and minimum mass, and need for various advanced computer-programing techniques and data input–output devices.

"Among many problems awaiting solution in the area of combat surveillance is need for a TV system using fiber optics, an improved high-resolution airborne radar for aerial surveillance, and inertialess tracking radar for counter-weapons location.

"In air navigation and traffic regulation, the Army is seeking, among other items, improved radio-communication antennas for aircraft, an aircraft troop-compartment loudspeaker system, a means for gap-filler communications, and an airborne single sideband (SSB) radio. These, of course, are but a few of the technological problems which need solving. A solution to any one of these or similar problems would substantially help the US military communications-electronics posture."

"Systematic planning is a must . . .
if there is to be integrated and effective world communication. By that I mean transmission across oceans and between continents. The bulk of such service has been for telephone and telegraph purposes, with sporadic use of facsimile, picture transmission, and sound broadcasting. Higher speed data transmission and greatly slowed-down TV have also been used on a limited basis recently. In the future, we may expect greatly increased demand for these services, and others as well.

"Despite the rapid extension of transoceanic cables, radio links in the 5 to 30-mc range, using reflection from the ionosphere, will continue to be a substantial part of the world-communication network. Tropospheric-scatter systems provide wider bands and more reliable transmission in the 500 to 2000-mc range.

"Radio communication via satellites will provide another great contribution to the transoceanic scene, but there are many problems yet to solve. Success will depend on the most advanced art that research has to offer. For one thing, the extremely high power required for the earth transmitters could result in widespread interference with other radio systems on the earth's surface. And conversely, high-power radar and other systems could produce serious interferences with the ground-based satellite receivers. The preferred frequency region for satellite communication seems to be about 1000 to 10,000 mc. Early consideration of international frequency allocation will be needed."

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Executive vice-president
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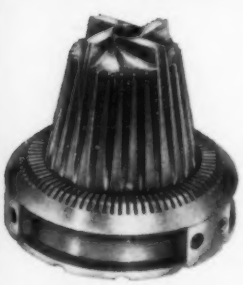

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READER TO EDITOR

Who Started the Count?

To the Editor:

In your Oct 31 '60, p 3, you said that Benjamin Thompson was made Count Rumford by King George III of England. Was it not the King of Bavaria?

—George P Anderson
Metals Research Lab
Brown Univ, Providence

• How right you are. Benjamin Thompson was made Count of the Holy Roman Empire in 1791. This was, as you said, while he was in Bavaria. Actually, all King George III did was to knight him; however, Thompson preferred the title Count Rumford to Sir Benjamin—Ed.

Engineers & Politics—a Good Mix?

To the Editor:

Your article "Are Engineers 'Too Good' For Politics?" (Nov 7, '60, p 24) is agreeably typical of the new stimulating trend to orientation for engineers and scientists. Of course we are all different—heredity itself guarantees that mathematically. But in any case, today it is most inhibiting, if not actually crippling, to be exclusively concerned with any full-time logistic specialty. Not only is the engineer not "too good" for politics, but also politics is not by any means "too good" for the engineer either.

—Robert G Wulff
Evanston, Ill

To the Editor:

Of course, I agree wholeheartedly with your thesis that the engineer is greatly needed in politics. The biggest problem that the employed engineer in politics faces is the typical businessman's attitude toward politics. For too many years, engineering employers have praised public effort, but derogated actual political work. Although I enjoy politics as a hobby, I feel sure that my fellow engineers think of it as a mean business. Possibly one reason is that work for the public is ideally unselfish and without error, while business is built primarily on the idea that acknowledged self-interest can be organized for good. The same kind of actions in business and in politics receive two completely different interpretations.

One problem of the employed engineer may destroy his political work and interest completely: the engineer's employer may simply transfer him to another part of the country! Then years of local effort and study of local problems go down the drain. Have you any answers for that problem? —Henry H Wakeland
NYC

To the Editor:

There is no advantage to be gained, no good purpose served in flaying technologists, scientists and engineers for lack of attention to social affairs. Our society has not desired this attention. Actually it has not permitted this attention, and it is a pity you haven't noticed this basic situation. Your nine suggestions will fall flat

as a pancake because the ground they have to rest on is too sterile to support growth. The situation you observed in lumping together technologists, scientists and engineers points to the outstanding characteristic of the group, and should indicate to you the chief factors responsible for sterility.

Today's society has asked nothing more of the technical man but technical services, creativity, productivity and managerial capacity. It has asked the scientists only to expand the frontiers of science. It wants the engineer to use science for the benefit of and to satisfy the needs of everyone. Analogous to the family as the personal unit of society, industrial and commercial organizations are the working units. Their main activity being work, one cannot expect of them a laboratory for settling social problems.

Social problems are firstly the interest of journalists, universities, politicians, religions and the other social professions, law and medicine. If these professions cannot influence society strongly enough to cure its ills, how can you expect the technical man to make any progress in this direction?

Engineers are very smart, but not that smart. Their job of work also doesn't permit spending much time on it. Personally I think it is amazing that men with scientific and technical training are at all proficient in the social scene. That some do attain favorable reputation does not condemn the rest of us. It condemns the social professions. —C R G HOLMES

Industrial Research Services
Ontario Research Foundation, Toronto

COMING EVENTS

9-13 . . . . Society of Automotive Engineers, International Congress & Exposition, Cobb Hall, Detroit

16-19 . . . . Instrument Society of America, Winter Conference & Exhibit, St. Louis

29-Feb. 3 . . . . American Institute of Electrical Engineers, Winter General Conference, NYC

FEBRUARY

1-3 . . . . Institute of Radio Engineers, Winter Convention on Military Electronics, Biltmore Hotel, Los Angeles

7-9 . . . . Society of the Plastics Industry, 16th Annual Technical & Management Conference, Edgewater Beach Hotel, Chicago

15-16 . . . . Institute of Radio Engineers, American Institute of Electrical Engineers, 8th Annual International Solid-State Circuits Conference, Univ of Pennsylvania & Sheraton Hotel, Philadelphia

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DRAFTING TRENDS

Helpful new booklet suggests drafting, engineering shortcuts

Just published—"DRAFTING SHORTCUTS" is a completely new booklet of helpful ideas and aids for engineers, draftsmen and students. It is well illustrated, clearly and logically written. It contains a wealth of time-saving tips to speed both routine and specialized tasks.

The ideas selected were submitted by professionals and judged by an impartial panel of widely recognized authorities on the various topics covered.

As an example, the section covering *Calculating Ideas* includes a simple means of locating stress points on cantilevered beams, also a simple method for retaining fundamental trigonometric relations.

In the section on *Drafting Shortcuts*, our editors have come up with topics like a simplified, fast and easy method for drawing gear teeth profiles and a rapid means of showing twisted wire elements.

The *Engineering Data* section covers new, easy-to-use shortcuts to formulas and engineering data.

There's a special section devoted to time-saving techniques on the drawing board, too. One of the suggestions on how to make life easier for the draftsman tells how to use a bent paper clip as a variable guide for making section lines.

For your free copy of "Drafting Shortcuts" contact your POST dealer or write today to the Frederick Post Company, 3642 N. Avondale Avenue, Chicago 18, Illinois.

POST

SENSITIZED PAPERS & CLOTHS • TRACING & DRAWING MEDIUMS • DRAWING INSTRUMENTS & SLIDE RULES
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RBW FASTENER BRIEFS

RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY

Technical-ities

By Fred E. Graves

Fastening of "vibration" joints

With static assemblies, your only fastening worry is enough safe load capacity. But with dynamic loading, you also have to guard against loosening.

HIGH THREAD TENSION

You'll find one of the best locking mechanisms within the fastener itself: high thread tension. Obviously, the tighter the fastener, the higher the tension and the better the "lock."

CASE HISTORIES

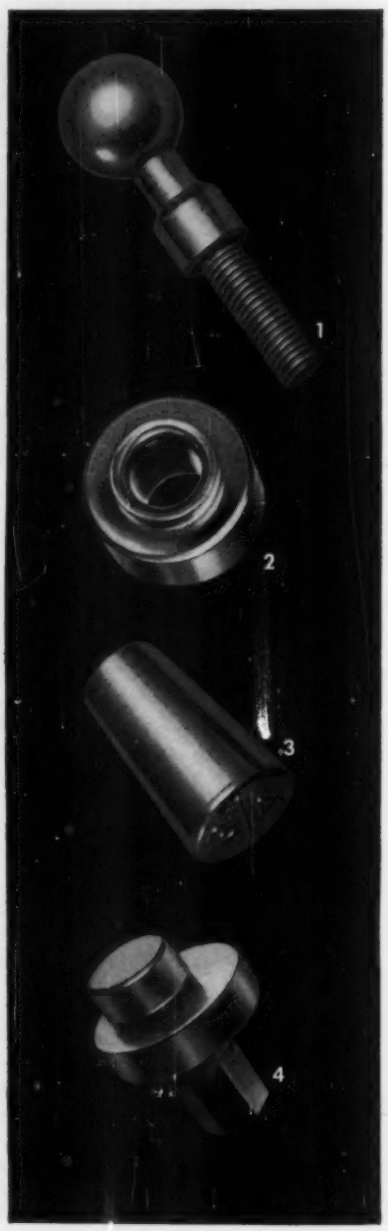
(1) Textile looms notoriously suffer from vibration. Yet their bolts stay tight *without any locking device* when highly preloaded. (2) Heavy duty shakers had joint loosening problem which was solved for good when the maker switched to *high strength hex bolts torqued up almost to yield strength.*

Using split lock washers gives no such guarantee against loosening. It becomes equivalent to a solid washer at a relatively low load level. Once the screw has loosened to the point where the washer becomes a spring, it's too loose for safety.

When you can't fully utilize a high strength fastener, go to a bolt with prevailing torque lock nut; or to a unit that combines high thread tension along with a high off-torque value (such as RB&W's TENSILOCK fasteners—see Bulletin TL-2.)

With vibration joints involving thin gauge or sheet metal, it's better to use a *thread-cutting* screw, than a machine screw in tapped hole. It gives 100% depth of thread contact for more thread friction to resist backoff.

Some ideas for savings through cold forming



It generally costs less to cold-form a part than to machine it, since there's less scrap loss and more speed. The cold working strengthens the part, too—improves its physicals.

These four cases show what happened when designers and production men referred their needs in special parts to RB&W.

1. **Ball-head stud.** Formerly produced on screw machine, this truck mirror pivot suffered high scrap loss, cost 75% more than it did when RB&W produced it by cold forming and some secondary machining.

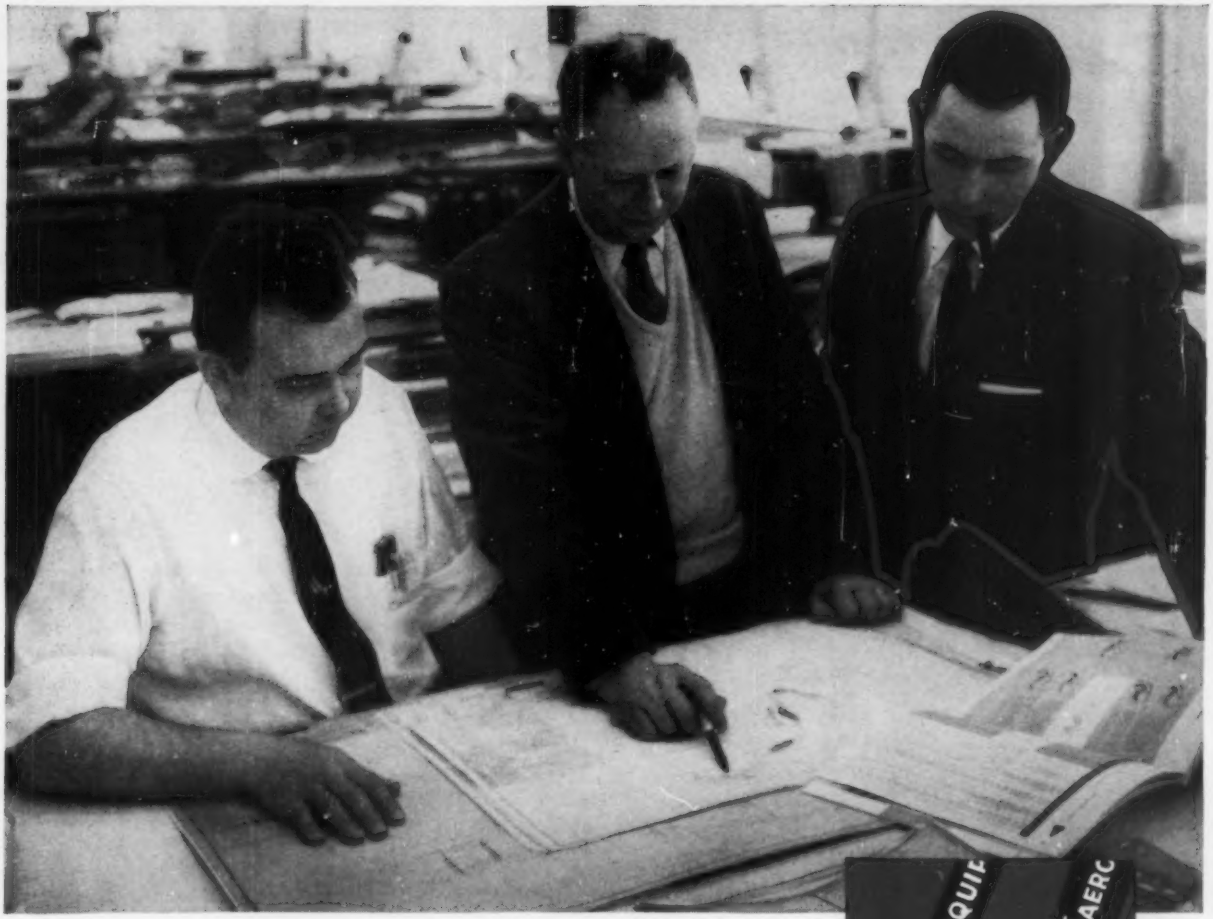
2. **Spacer.** Cost of this automobile trunk hinge spacer was cut 50% when RB&W cold-formers took on the job of pounding them out at high speed, finely finished and ready for installation.

3. **Taper plug.** Time and money were both saved by manufacturer of expansion bolts who came to RB&W to make these parts. Cold headers formed them faster than screw machines, and with zero scrap.

4. **Adjustment cam.** Cold forming affords the *only* economically feasible way to produce this part. Due to its large eccentric and hex end, machining and material costs would be excessive.

These examples typify a range of work from RB&W cold heading and cold forming facilities. RB&W also performs many secondary operations on parts to specification, such as drilling, slotting, knurling, etc. Best way to see whether you have a part that could cost you less is to refer it to RB&W for study. Write Russell, Burdsall & Ward Bolt and Nut Co., Port Chester, New York.

Plants at: Port Chester, N. Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional sales offices at: Ardmore (Phila.), Pa., Pittsburgh; Detroit; Chicago; Dallas; San Francisco.



Aeroquip Fluid Piping Service Assists Product Design Engineers

Major equipment manufacturers can use Aeroquip's Fluid Piping Service to great advantages in developing fluid systems that will provide dependable, trouble-free service in the field. Highly qualified Aeroquip Sales Engineers, for example, are on call to furnish valuable design assistance. Working right in your engineering department, these fluid piping design specialists give you the full benefits of the experience Aeroquip has gained by working with many other manufacturers.

This design assistance is only part of Aeroquip's complete service. Backed by the most complete line of fluid piping products, Aeroquip's specialists can also help you mock up and test systems, work with your production planners and expediters and assist in developing a service parts program. Aeroquip can even furnish trained field service engineers to assist in after-sales service on your equipment.

For detailed information, call your nearby sales engineer, or write to us.

Aeroquip fluid piping specialists can work with you in every phase of manufacture to assure maximum performance of fluid piping systems on your products.

Aeroquip now produces a wide range of fluid piping products, including hose assemblies with standard or special tube configuration fittings, Self-Sealing Couplings and a new line of tube fittings.

Aeroquip

REG. TRADEMARK

AEROQUIP CORPORATION, JACKSON, MICHIGAN

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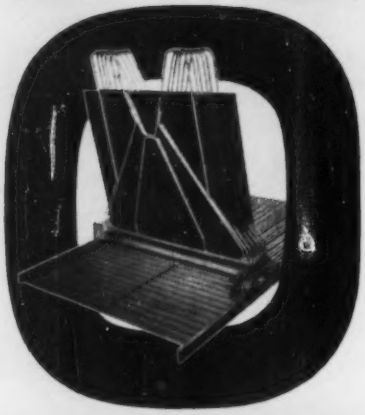
AEROQUIP (CANADA) LTD., TORONTO 19, ONTARIO

AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN U.S.A. AND ABROAD

CIRCLE 31 ON READER SERVICE CARD

SICON® PROTECTS even in HOT OVENS



Young Brothers Co., Cleveland, a leading manufacturer of industrial ovens for the metal decorating field, uses SICON finish to protect oven wickets. Printed metal sheets are oven-dried before being formed into signs, cans, etc. As they pass through the 100 ft. oven the Sicon-coated wickets hold them in position as shown. SICON has proved most satisfactory because it keeps wickets clean, rust-free, and unaffected by temperatures in the 400° - 600°F. range. Why not try SICON on your product! Write Dept. A-31.

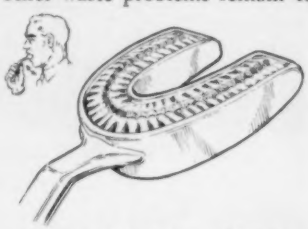
Sicon®
Hi-Temperature Finish
by MIDLAND
Industrial Finishes Co.
Waukegan, Illinois

WHY DON'T THEY R&D..?

. . . ways to dispose of (or utilize) a variety of industrial wastes. Widespread use of some valuable industrial processes is hampered because there is no way to dispose of harmful wastes. Cyanide leveling baths, for example, (in electroplating, they eliminate buffing and permit a uniformly thick lustrous coating to build up in a short time) are a typical industrial troublemaker. Most plating shops prefer to spend the time and money involved in the additional handwork because they have no way to get rid of poisonous cyanide when the bath is spent. You can't pour it down the drain and it's not even very safe to bury it. The only answer is to reclaim it—a lengthy and expensive process. Perhaps there is some way to modify the CN radical to neutralize its toxicity—possibly by converting it to nitrogen-based fertilizer.

What can be done with atomic waste? At the present time, it is put in lead-lined cans and dumped in the ocean. Although it's no longer useful in a reactor, it is still hot—in both the atomic and thermal sense. It might make a compact heat source for some application. Or maybe it could be combined with the aggregate in concrete to make ice- and snow-free roads, runways.

Such problems have been solved before. Copper smelting became a paying proposition when processors learned to recover the gold, tellurium, bismuth and other precious metals that previously disappeared up the stack. Castoff tailings from coal mining became a valuable source of coal when powerplants developed burners to handle pulverized as well as lump coal. Blast furnace slag is now used as lightweight concrete aggregate and insulation. But many other waste problems remain to be solved. —H Lau



. . . an improved method for cleaning teeth.

With a little ingenuity it should be possible to design an instrument that would clean quicker and more effectively than the present toothbrush—a design that's remained pretty much unchanged for over 500 years. Here are two suggestions.

An arc-shaped, two-sided brush, bent to fit the curvature of the teeth. When inserted in the mouth, normal chewing action brushes both sides of the teeth with the recommended up-and-down motion. Core of the brush would be made of a material that is easily bent to fit the shape of any user's mouth.

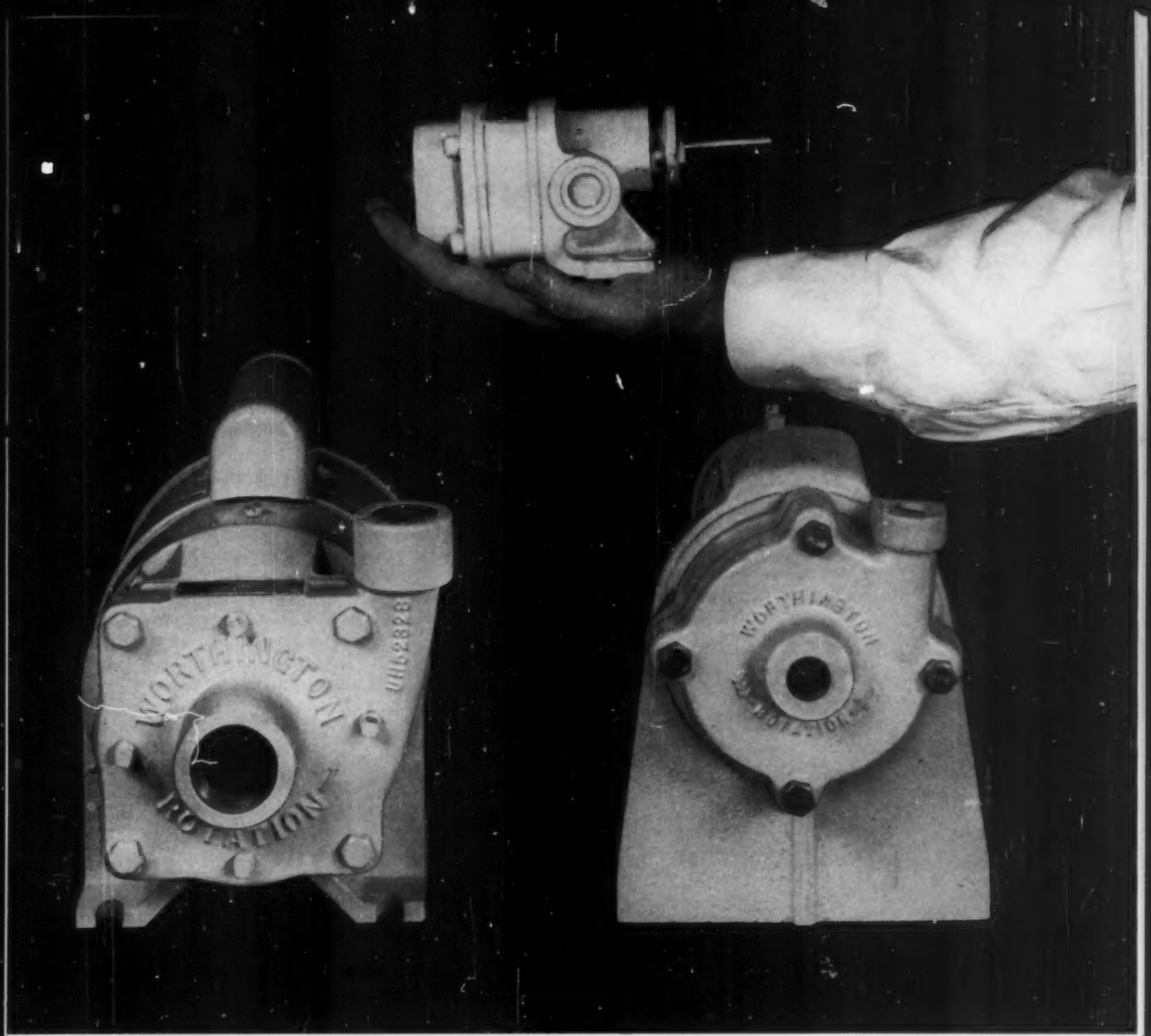
—L M Allison

A detergent mouthwash used in combination with an ultrasonic transducer. When the transducer is energized in a mouthful of dilute cleaning solution, it loosens food particles and massages gums—and perhaps it would kill residual bacteria. Frequency and amplitude would be chosen to avoid annoying resonances and minimize the danger of loosening fillings. If transducer were kept in a sterilizer-receptacle, only one such device would be needed per household. —T N Tyler

. . . a small, one-shot, tape recorder for catching significant comments and ideas in conferences, and pieces of melodies while composing music. It could be a very simple device; a 15-minute loop of tape would circulate continuously, erasing itself and re-recording. Fidelity would not be important and tape could be played back on a standard tape machine. It would only be necessary to plug the machine in and leave it running; when there's something you want to save, just snatch out the tape cartridge and replace it with another.

—F Depew

Have you a problem, based on known scientific principles, which seems to have an answer somewhere within the limits of present technology? To inspire inventors along worthwhile paths, PRODUCT ENGINEERING invites you to trade such problems with fellow readers who have a fresh viewpoint or more time to experiment. We pay $10 for each one accepted.



WE'RE BIG IN SMALL PUMPS, TOO

Yes, we're big in small pumps, too . . . so big that we have a complete, separate plant* for their production. But the real proof of how we can meet your small pump needs lies in the extent of our small pump lines. Look how these three new models stretch down to cover many more "small pump" applications.

Look at the new 1" Centrifugal which efficiently handles small flows from 2 to 80 gpm at heads to 110 feet. It's competitively priced, compact and trouble-free with smoother waterways and higher efficiencies.

Or look at the rotary which performs down to 4 gpm (150 psi) at 1750 rpm. It has one stuffing box to minimize leakage, few moving parts to cut maintenance, excellent suction lift, four-bearing construction, and the herring-bone gears that are quieter and more efficient than spur gears.

For chemical and related industries, there is the new ⅜" Worthite pump with capacities to 18 gpm and heads to 55 feet. It has all the corrosion-resistant advantages of larger Worthite standard centrifugal pumps.

There are, of course, special advantages in buying small pumps from Worthington. One is that you're getting Worthington "big pump" quality. Another is that the small Worthington pumps are stocked and serviced coast-to-coast. Thus you can standardize in many locations and still get quick pump service anywhere. (Original equipment manufacturers, take note!)

For more information write Worthington Corporation, Section 20-25, Harrison, New Jersey.

*Located in East Orange, N. J. Our main large-pump plant is in Harrison, N. J.

WORTHINGTON

CIRCLE 33 ON READER SERVICE CARD

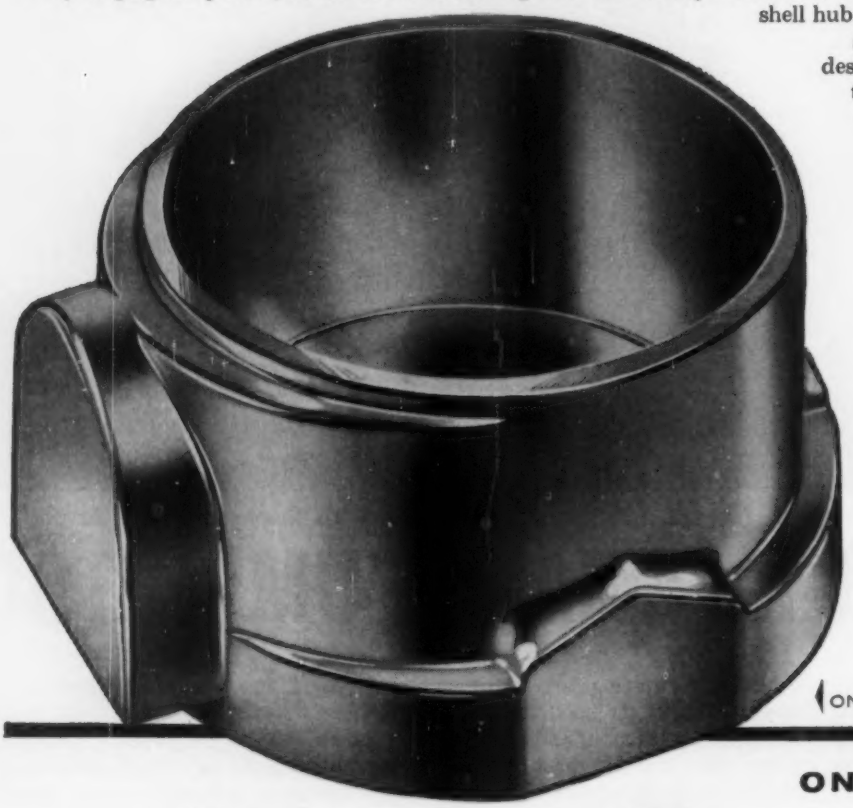
MUELLER BRASS CO. PRODUCES

SPECIFICATIONS . . . *REGARDLESS OF*

To obtain the desired physical and design requirements in a part at the lowest cost, there is usually one specific process by which that part can be most successfully and economically manufactured. Because the Mueller Brass Co. offers a variety of production methods, you get sound engineering, accurate production method analysis, our assurance of getting the best product at the lowest cost . . . regardless of metal specified or the size of your particular part.

BRASS, BRONZE, ALUMINUM FORGINGS

The two parts shown here dramatically illustrate the ability of the Mueller Brass Co. to produce precision forgings regardless of size or configuration. Both the tiny dental drill nozzle and the big heat exchanger shell hub, which is the largest of its kind ever produced, were forged to exacting specifications. The weight of the nozzle is only a few ounces while the shell hub weighs 40 lbs., and has a forged pocket 7 1⁵⁄₁₆″ in diameter and 4⅜″ deep. By way of size comparison, the pocket is big enough to hold over 14,000 of these tiny drill nozzles. By forging the pocket, considerable machining time and money was saved. The sound, dense structure of the shell hub makes it ideal for the high pressure application for which it was designed. The forging not only does the job better, but was produced for 25% less than the casting it replaced. Experience makes it possible for the Mueller Brass Co. to produce high quality precision forgings regardless of specifications . . . why not put this experience to work for you?



ONE-HALF SIZE

ACTUAL PART SIZE

Write today for Engineering Bulletins on any of these Products.

SCREW MACHINE PRODUCTS

ONE DEPENDABLE

POWDERED METAL PARTS

MUELLER BRASS CO.

MUELLER BRASS CO.

PARTS ECONOMICALLY...TO EXACT

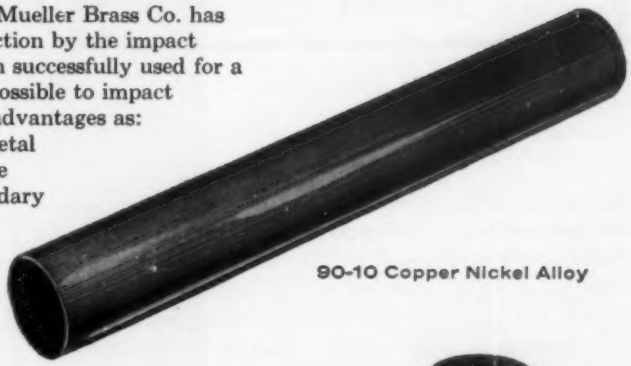
METAL, METHOD OR SIZE...

When you are designing, specifying or purchasing fabricated parts, call in the "Man From Mueller Brass Co." to help lower costs and improve your products. Sales and engineering service is available to you at Mueller Brass Co. offices throughout the United States. Make Mueller Brass Co. your one dependable source for all your part needs.

COLD PREST® IMPACT EXTRUSIONS

Today, because of vast experience in alloys, the Mueller Brass Co. has greatly expanded the possibilities of parts production by the impact extrusion method. Aluminum, of course, has been successfully used for a multitude of tubular shapes. But now it is also possible to impact parts of copper alloys incorporating such major advantages as: closer tolerances, better finish and appreciable metal savings. Because of dimensional accuracy possible with the impact extrusion, the necessity of secondary machining operations is often eliminated.

The parts shown here are representative of the group now being economically produced as impact extrusions by the Mueller Brass Co. who offer complete engineering and design service in the development of new parts from copper base alloys.



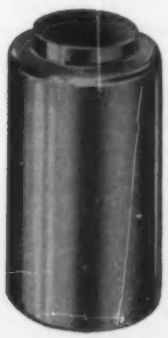
90-10 Copper Nickel Alloy

Aluminum Alloy 6061

Oxygen Free High Conductivity Copper

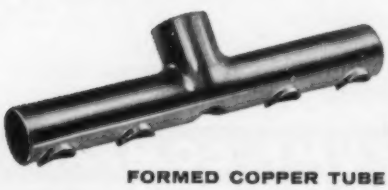
Special Alloy 902

Tellurium Copper Alloy

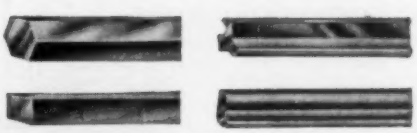


Low Phosphorus Copper Alloy

SOURCE FOR ALL THESE OTHER PRODUCTS



FORMED COPPER TUBE



STANDARD and SPECIAL ALLOY ROD

MADE IN U.S.A. TO THE STANDARDS OF AMERICAN INDUSTRY

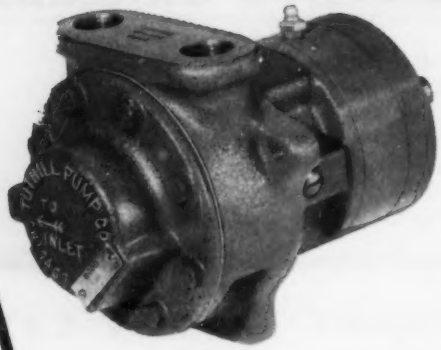
PORT HURON 29, MICHIGAN

319

CIRCLE 35 ON READER SERVICE CARD 35

TUTHILL automatic reversing pumps

- Positive reversing action
- Require no valves
- Port positions remain constant



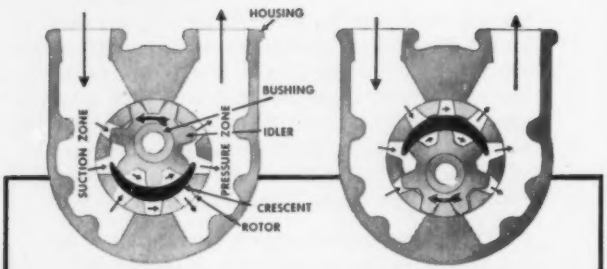
The model RCK above is typical of Tuthill's complete line of automatic reversing pumps . . . which use the time tested operating principle at the right to provide instantaneous, positive reversing action without the use of valves. The port positions remain constant regardless of the direction of shaft rotation. And all pumps provide uniformly high efficiency in both flow directions.

The automatic reversing design was developed by Tuthill for applications where the pump must be driven from a reversing shaft, or where machinery must be shipped without knowing the ultimate direction of the driving unit. These pumps have been enthusiastically accepted by designers and have proven their dependability in thousands of demanding applications such as large air compressors and machine tools.

375 Models

A complete selection of 375 models is provided with capacities from ⅓ to 200 gpm; for pressures to 400 psi; and speeds to 1800 rpm. Included are a complete assortment of stripped models specially developed for incorporation into manufactured products.

A 12-page catalog, No. 105, gives complete information on all Tuthill automatic reversing pumps. Write today for your copy. Or, if you desire, send drawings so that Tuthill's engineers can show you how the Model R reversing pump can be built directly into your product.



COUNTER-CLOCKWISE ROTATION

CLOCKWISE ROTATION

THE PUMPING PRINCIPLE

Tuthill automatic reversing pumps are based on the use of a rotor, idler gear and a crescent shaped partition which is integral with a moving part called the Idler Carrier.

Figure 1 shows how power is applied in counter-clockwise rotation to the rotor and transmitted to the idler gear with which it meshes. The space between the outside diameter of the idler and the inside diameter of the rotor is sealed by the crescent. When the pump is started there is an increase in volume as the teeth come out of mesh. This creates a partial vacuum, drawing the liquid into the pump through the suction port. The liquid fills the spaces between the teeth of the idler and rotor and is carried past the crescent partition to the pressure side of the pump. When the teeth mesh on the pressure side, the liquid is forced from the spaces and out through the discharge port.

When the shaft rotation changes from counter-clockwise to clockwise, the idler carrier (including the idler gear and crescent) automatically rotates 180° through the suction zone to the position shown in Figure 2 which *changes the direction of flow within the pump* without changing port positions. The idler carrier rotates in a cover casting fitted with stops so that the crescent can rotate only 180°—always through the suction zone. Upon resumption of counter-clockwise rotation, the crescent will swing back to the original position in Figure 1.

Tuthill Manufactures a Complete Line of Positive Displacement Rotary Pumps in Capacities From ⅓ to 200 GPM; for Pressures to 1500 PSI; speeds to 3600 RPM.

PUMPS FOR YOUR PURPOSE

TUTHILL PUMP COMPANY

963 East 95th Street, Chicago 19, Illinois

NFPA NATIONAL FLUID POWER ASSOCIATION

75-MILLIONTHS OF AN INCH BARRIER HALTS METAL MIGRATION

JUST BENEATH THE FRESH OVERPLATE OF THESE F-M ENGINE BEARINGS (LEFT) LIES A TENUOUS DIFFUSION BARRIER. Though this film of metal is only 75-millionths of an inch thin, it stops tin in the overplate from migrating into the lining metal beneath. Its presence is important to bearing overplate performance, particularly during the critical period of engine break-in. Maintaining uniform thinness as well as uniform composition of the plated barrier is most important . . . and most difficult to achieve on a production scale. Federal-Mogul research has developed a unique, extraordinarily precise method for controlling both the thinness and the metallic composition of this barrier, within narrow limits. And the performance of F-M engine sleeve bearings attests to the success of the method!

RESEARCH INTO ELECTROPLATING problems is a continuing project in the F-M laboratories. Unusual precision equipment and facilities are employed, many of which have been specially designed and engineered by F-M to solve problems of sliding-bearing application. As a result, Federal-Mogul engineered sleeve bearings, precision thrust washers, formed bushings, and low-cost spacers provide the finest possible performance characteristics for any application.

Have you a problem with bearings, bushings or washers? Are you considering the development or redesign of an item of the type shown above? We'll be glad to show you how the job can be done most effectively and economically. For information, write Federal-Mogul Division, Federal-Mogul-Bower Bearings, Inc., 11043 Shoemaker, Detroit 13, Michigan.

FEDERAL-MOGUL

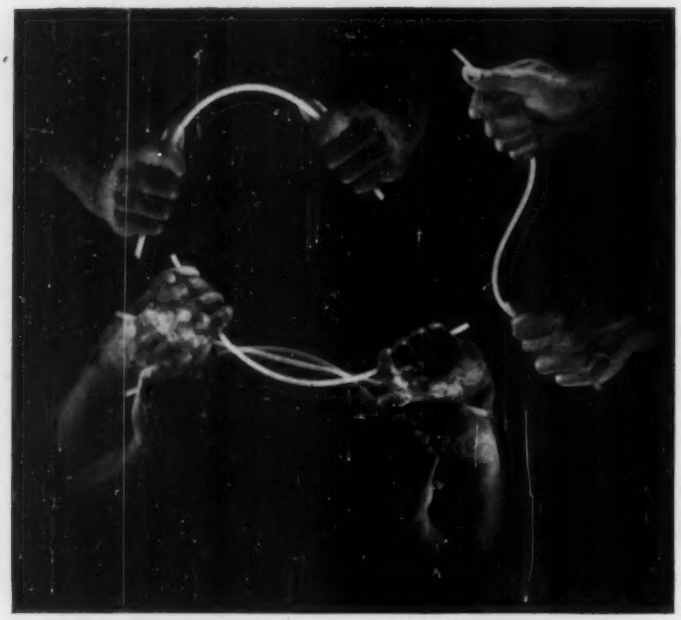
sleeve bearings
bushings-spacers
thrust washers

DIVISION OF
FEDERAL-MOGUL-BOWER
BEARINGS, INC.

CIRCLE 37 ON READER SERVICE CARD

NYLON PRESSURE TUBING

for Hydraulic-Pneumatic Service



CHEMISEAL Nylon Pressure Tubing can be flexed, twisted or bent into all contours, offers wide design "leeway."

Flex it . . . twist it . . . bend it! In fact, shape Garlock CHEMISEAL Nylon Pressure Tubing into practically any contour you need. Think what this means in design freedom and versatility.

For hydraulic-pneumatic systems, pressure lubrication lines, oil and fuel lines, vacuum system connections. Garlock CHEMISEAL Nylon Pressure Tubing is a superior design material. It is unaffected by oils, alkalies, hydraulic fluids, and many solvents that tend to corrode metal. It resists vibrational fatigue, abrasion, impact . . . withstands temperatures from −60°F. to +180°F. (can be heat stabilized for 300°F.) . . . available in 1000 and 2500 psi. grades, conforming to J.I.C. specifications. Diameters from ⅛" O.D. up to largest size commercially made, depending on customer needs.

To guarantee you best performance possible, CHEMISEAL Nylon Pressure Tubing is subjected to severe tests. For example, the Anvil Impact Test simulates the mechanical abuse that may accidentally occur in service. CHEMISEAL Nylon Pressure Tubing is placed on a flat steel anvil. A 16-pound hammer with a striking head of 6" drops freely onto the tubing from a height of 24". The Roll Bend Test assures freedom from defects which cause flex fatigue. Tubing is passed around and between two grooved rollers to form an "S" shape. Space between rollers is twice the diameter of the tubing. Tubing is then moved back and forth at a rate of at least 125 f.p.m.

In cost, too, Garlock CHEMISEAL Nylon Pressure Tubing has the advantage. Seamless copper and extruded aluminum cost approximately four times as much, while welded and seamless stainless steel costs 29 to 37 times more, respectively. Also, the cost of couplings and installation labor should be considered—CHEMISEAL Nylon Pressure Tubing needs no intermediate couplings or fittings . . . is simple to install. You save on first cost, fittings, and labor.

Discover how you can use CHEMISEAL Nylon Pressure Tubing. Call your local Garlock representative at the nearest of the 26 Garlock sales offices and warehouses throughout the U.S. and Canada. Or, write for Catalog AD-177. Garlock Inc., Palmyra, N. Y.

GARLOCK

Canadian Div.: Garlock of Canada Ltd.

Plastics Div.: United States Gasket Company

Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Products

NEW SMALL MAGNETIC STARTER COSTS LESS, SAVES SPACE ON LOW-HORSEPOWER JOBS!

Square D NEMA Size 00 Starter Rated ¾ to 2 Hp for 3-Phase Service

• You no longer need to buy more starter capacity than you can use for low-horsepower jobs! This new Square D Size 00 starter is compact, easy to install, simple to use and maintain—and it costs 18% less than the Size 0 starter you formerly had to specify to get the advantages of magnetic control! With no sacrifice in quality, this new starter provides: straight-through wiring—pressure-type terminals—1-piece overload relays for complete motor protection—pushbutton or selector switch optional in the cover. Also available without overload relays.

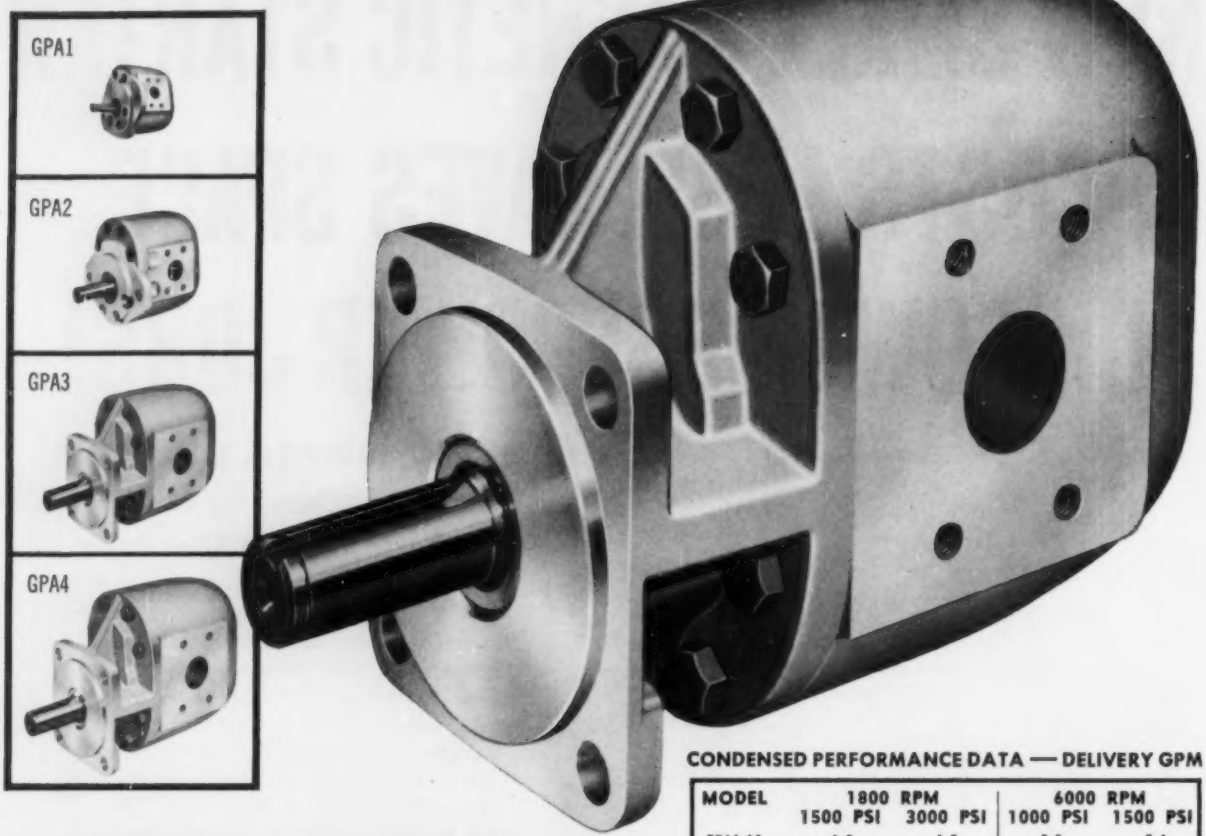
GET THE COMPLETE STORY! Write for Bulletin SM-297. Square D Company, 4041 North Richards St., Milwaukee 12, Wisconsin.

New starter is available either open or in NEMA Type 1 enclosure. Enclosure shown with selector switch in cover.

SQUARE D COMPANY

wherever electricity is distributed and controlled

Less hydraulic system heat



BERRY/DOWTY*
HYDRAULIC GEAR PUMPS

FOUR MODEL GROUPS — PRESSURES TO 3000 PSI
OUTPUTS FROM 1/2 TO 85 GPM

The use of Berry/Dowty gear pumps will reduce hydraulic system heat build-up through more efficient pump performance. Volumetric efficiencies of 95% at 2000 PSI are normal for these pumps. This feature combined with metered, pressurized lubrication of the bearings (independent of discharge pressure) assures you of long trouble-free performance of the heart of your hydraulic system. For more efficient performance over a wider range of pressures, temperatures, and speeds use the Berry/Dowty pressure balanced gear pump.

**Dowty is the tradename of Dowty Hydraulic Units Limited, England.*

CONDENSED PERFORMANCE DATA — DELIVERY GPM

MODEL	1800 RPM		6000 RPM	
	1500 PSI	3000 PSI	1000 PSI	1500 PSI
GPA1-10	1.6	1.5	5.5	5.4
GPA1-15	2.3	2.1	8.0	7.8
GPA1-20	3.2	2.9	10.9	10.6
GPA1-25	3.9	3.7	13.2	12.9
	1800 RPM		**3600 RPM**	
	1500 PSI	**2500 PSI**	**1000 PSI**	**2000 PSI**
GPA2-45	6.9	6.4	14.0	13.2
GPA2-65	9.7	9.2	19.8	19.2
GPA2-85	12.9	11.9	26.0	24.4
	1800 RPM		**2500 RPM**	
	1000 PSI	**2000 PSI**	**1000 PSI**	**2000 PSI**
GPA3-115	18.0	17.2	25.0	23.5
GPA3-170	25.5	24.5	35.2	33.1
GPA3-250	38.0	36.0	52.4	48.9
	1800 RPM		**2200 RPM**	
	1000 PSI	**2000 PSI**	**500 PSI**	**1500 PSI**
GPA4-300	45.5	43.5	56.1	54.4
GPA4-400	59.4	56.7	73.8	70.8
GPA4-500	74.2	70.4	91.7	89.3

All units available for clockwise or counterclockwise rotation. Also available as gear motors.

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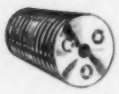

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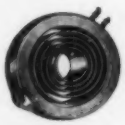

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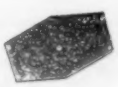
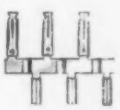


Plates

Retainers

Stampings



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6003

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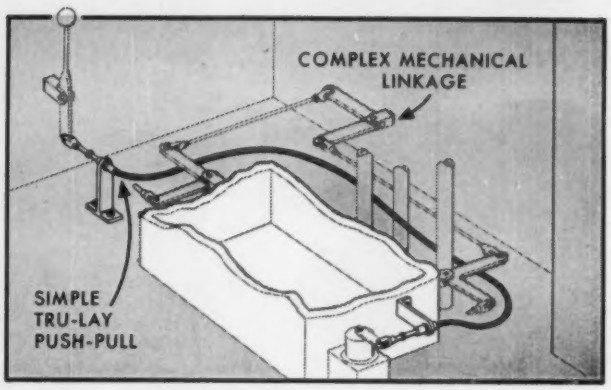

Sizes and Operating Heads to Fit Your Design

Control Dimension	Minimum Recommended Radius in Inches	Maximum Input Load in Pounds (Dependent on Travel)
3/32"	2	30
1/8"	3	65-125
3/16"	5	115-175
1/4"	6	300-600
5/16"	8	700-1,000

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Micro Control • Push or pull the knob for instantaneous response, then rotate knob for vernier adjustment. Built for smooth, efficient operation on any job.

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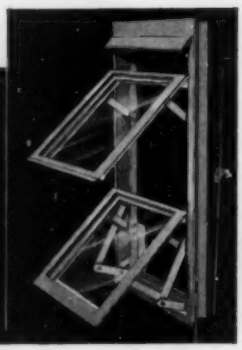

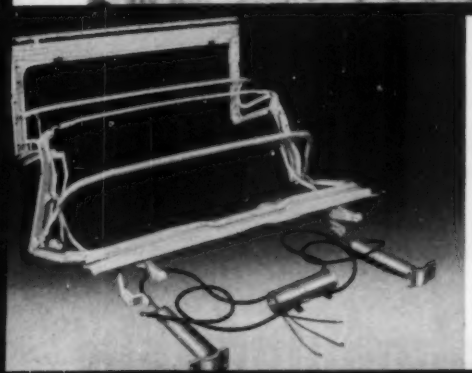

Dura Actuators raise and lower head and foot sections of Dura Select-A-Rest adjustable bed.

Dura Actuators raise and lower convertible tops, car windows, rear decks, etc.

Dura Actuators operate marine clutch and transmission mechanisms, power steering, and can tilt and lower large outboards.

Those "magic muscles" for opening, closing, lifting, lowering, pushing, pulling, turning, starting, stopping things—the team at Dura has more experience in them than any other team in the country, maybe in the world.

AND ideas. Experience begets ideas, good ideas, ones that work—and save your money.

For instance, millions of fingers press buttons in automobiles for things to happen and Dura Actuators MAKE them happen—windows go up or down, tail-gates or trunk lids move, seats move in any of half-a-dozen directions, convertible tops go up or down, lock and unlock, or ride levelers are adjusted. And, that's only the automobile business. Dura's "magic muscles" work in scores of applications, in fact, in ANY application where an electro-mechanical or electro-hydraulic actuator is the logical and thrifty answer.

And, don't forget that most of those Dura Actuators are compactly stowed in out-of-the-way spots where they don't intrude into useful space, and they're built to stay there and do their job with little or no attention — ever.

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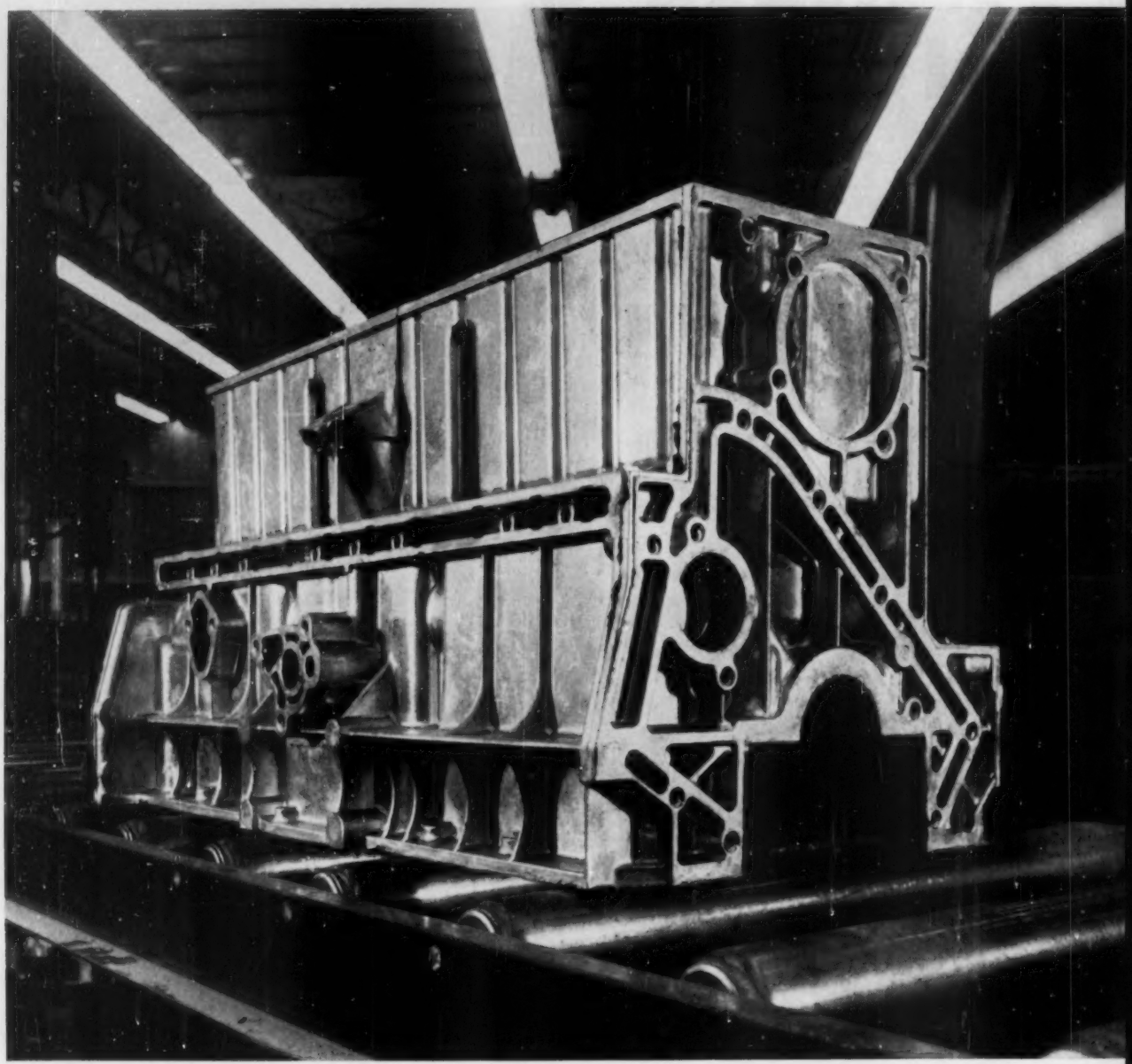


World's first die-cast aluminum "six"

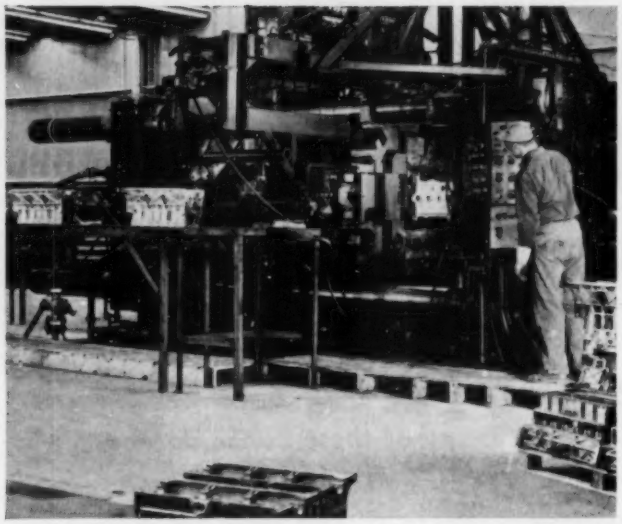
Saves 80 pounds for American Motors' new Rambler Classic . . . incorporates specially bonded cast iron liners in dry sleeve design.

This engine block is the biggest die casting ever mass produced. It's the world's first six-cylinder block for passenger car use to be die cast in aluminum.

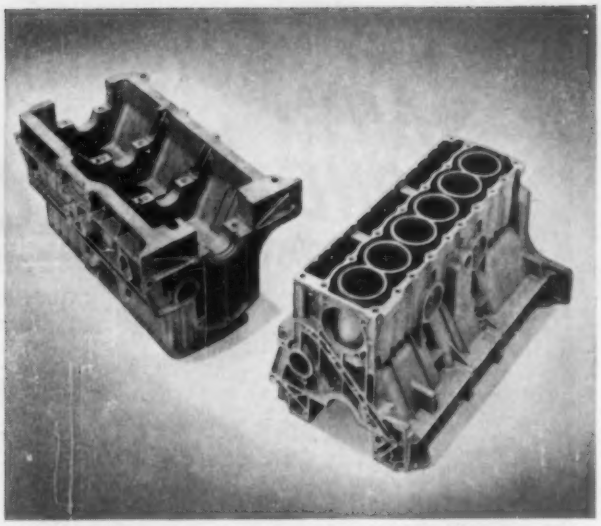
It's a 67 pound lightweight including 14 pounds of centrifugally cast iron cylinder liners. That means a total saving of 80 pounds deadweight . . . now standard in the new Rambler customs, optional in other Rambler models.

Light but strong. Aluminum's excellent physical properties are fully utilized by careful die cast design and photostress analysis. Outstanding strength, soundness and precision provide a big plus for heavily-emphasized Rambler quality.

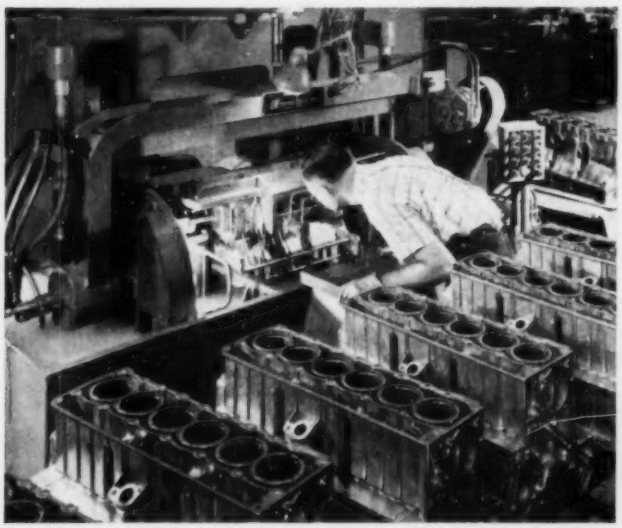
BMI bonding is simple and sure. The BMI—or Bi-Metallic Interlock developed by Doehler-Jarvis—mechanically "anchors" the liners by means of their specially prepared cast surfaces. Since these liners are centrifugal castings, no knurling, crimping or splining is needed. An intimate locking action occurs as the molten aluminum is injected into the die . . . under 8,000 psi. The result: an inseparable bond with excellent heat-transfer properties.



A block every three minutes . . . from 2,000 ton machines like this. In three tenths of a second, machine injects a 70-pound "shot" of molten aluminum . . . under 8,000 psi.



Centrifugally cast iron liners—up to 260 Brinell—are cast in place with specially prepared surfaces which lock inseparably with molten metal under pressure.



Pressure tightness of die-cast aluminum blocks is determined by testing on a machine specifically designed for this purpose. Advanced quality control helps protect highest standards.

Palletized for rapid delivery, these finished blocks can reach American Motors assembly plants by rail . . . or in trucks of the Doehler-Jarvis fleet.

rolls off the line at Doehler-Jarvis

To design for efficient production, American Motors and Doehler-Jarvis engineers combined specialized know-how with liberal imagination. An oil gallery for hydraulic valve lifters is an integral part of the block casting. Liner inserts and loose pieces for casting undercuts are placed by automatic attachments that never slow down the casting cycle.

To make new ideas pay off, perhaps you can use the facilities, resources and practical experience offered by Doehler-Jarvis. Eight plants provide the capacity—and the flexibility—to serve large companies well, and to help small ones grow. For detailed information, simply phone or write the nearest Doehler-Jarvis plant or office.

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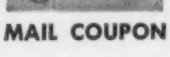

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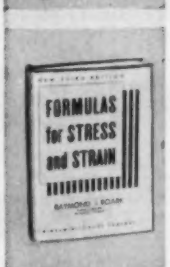

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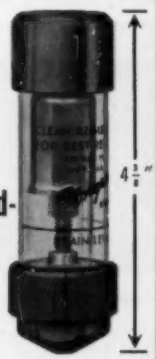

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Model 30BJ-1
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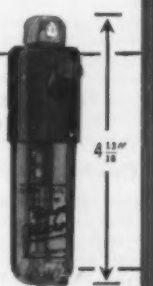

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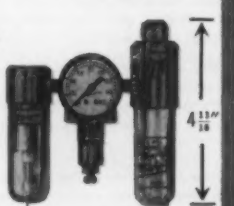
Model 10AH-1L—lubricates air-operated equipment.

Both models ¼" pipe size.



Micro-Fog Lubro-Control Units

The new Norgren compact units may be used singly or in combination. Illustrated is a lubro-control unit made up of a 30AJ-1 filter, 20AR-1GG regulator and 10AH-1L lubricator—¼" pipe size.

Norgren compact units give you big performance in small space. For complete information on the complete line of Norgren filters, regulators and lubricators in all sizes, call your nearby Norgren Distributor, listed at left—or write for brochure NA-3.

C. A. NORGREN CO. FOUNDED IN 1926

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News about

R&A Adhesives

SINCE 1913

FOR ALL METALS AND ALL PLASTICS

Modern epoxies can be sprayed, brushed, dipped, roll-coated, dusted, extruded, trowelled, spread

TECHNICAL DATA ON

Bondmaster® Series "M"

EPOXY ADHESIVES

One of our epoxy formulations has a viscosity of about 300 cps . . . literally flows like water. At the other end of the scale are void-filling thixotropic adhesives which spread like a heavy cold cream but won't sag or flow in vertical or overhead applications . . . or even when heat-cured.

In between, more than a score of BONDMASTER epoxy-based adhesives offer a wide range of handling characteristics, curing cycles, and differing degrees of tensile strength, flexibility, heat-resistance, etc.

"ROOM TEMP" OR HEAT-CURING

Some of these products cure at ambient temperature, some require heat. Some are versatile enough to permit their use both ways: there's one room-temperature-curing formulation which reaches "handling strength" in about six hours but which can be cured in as little as 10 minutes at 150°F.... even more swiftly at higher temperatures. (None of the 100%-reactive formulations require any more pressure than is needed to maintain contact during cure.)

END-USE SERVICE CHARACTERISTICS

These formulated epoxy adhesives will bond *all* metals and almost all plastics to themselves or to each other . . . or to wood, ceramics, or just about any other materials, for that matter. As a group, they exhibit minimal shrinkage, are electrical insulators, and provide excellent resistance to weather, galvanic action, and most chemicals, acids, and alkalies.

They are available as liquids, pastes, mastics, syrups, films, and powders . . . yielding tensile strengths among the highest attainable within the scope of present-day adhesive technology.

•

Write for Technical Data Sheets detailing adhesive laydown, curing cycles, bonding methods, etc., of BONDMASTER Series "M" Structural Adhesives.

R&A SINCE 1913

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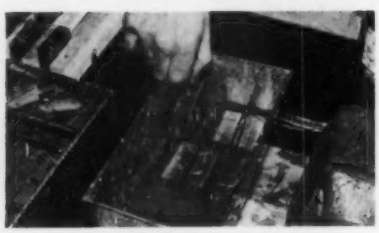
235 BELLEVILLE AVENUE
BLOOMFIELD, NEW JERSEY

"Styrofoam" to magnesium (M685)

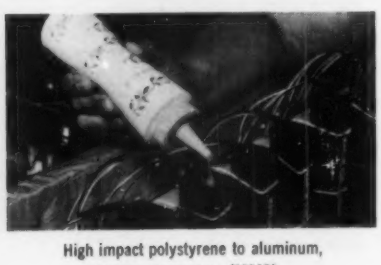
Phenolic to brass (M648T)

Silicon steel laminates (E645)



Rotary solenoid stators (E621)

Alnico magnets to zinc castings (M620)

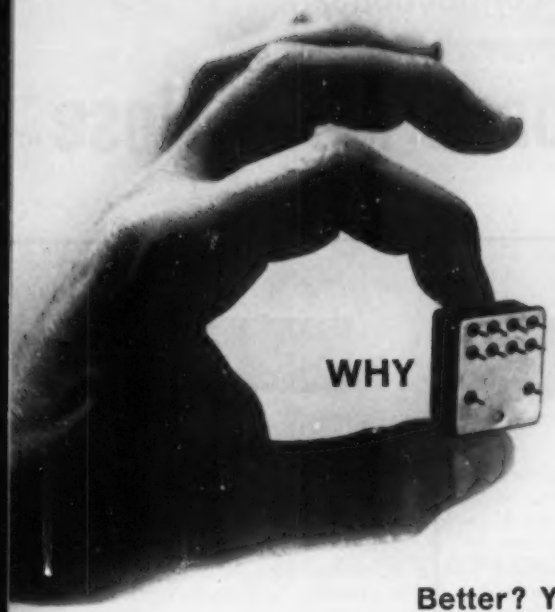


High impact polystyrene to aluminum, copper, neoprene (M648)

Galvanized steel to aluminum (M688)

•

If the handling characteristics of the adhesive you are using don't match your most efficient production demands, chances are there's a standard BONDMASTER formulation that will! If you will detail your problem, we'll be glad to send samples . . .



WHY THIS IS A BETTER *LATCHING* RELAY

Better? Yes, in several ways. Bifurcated Contacts, for example, give improved reliability, especially in dry circuits. Contacts will not open during vibrations of 30Gs, 55 to 2500 cps. A special method of sealing cover to base eliminates flux contamination of the contacts. And there are more. Here is Potter & Brumfield's newest member of a distinguished family of micro-miniature relays: the FL Series.

Expressly designed for printed circuit applications, this DPDT, 3 amperes (@ 30V DC) latching relay lies parallel to the mounting surface. Its height, when mounted, is only .485", thus circuit boards may be stacked closer. Mounting can usually be accomplished without studs or brackets, simplifying installation.

The FL will remain firmly latched in either armature position without applied power, a significant advantage where power is limited and long relay "on" times are required. This relay may be operated by:

1. Pulsing each coil alternately (observing coil polarity), or
2. Connecting the coils in series and operating from a reversing (polarized) source.

Write for complete information or call your nearest P&B representative.

FL SERIES SPECIFICATIONS

Shock: 100 Gs for 11 milliseconds. No contact openings.

Vibration: .195", no contact openings. 10 to 55 cps. 30 Gs from 55 to 2500 cps.

Pull-In: 150 milliwatts maximum (standard) at 25° C. 80 milliwatts maximum (special) at 25° C.

Operate Time: 3 milliseconds maximum at nominal voltage at 25° C.

Transfer Time: 0.5 millisecond maximum at nominal voltage at 25° C.

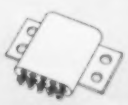
Temperature Range: −65° C to +125° C.

Terminals: Plug-in pins.

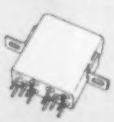
Dimensions: L. 1.100" Max.—W. .925" Max H. .485" Max. Hermetically sealed only.

SC 11 D

SCG 11 DC



SL 11 DB (Latching)



SLG 11 DA (Latching)

Other P&B micro-miniature relays include conventional and latching models in crystal cases with a wide range of terminals and mountings. All are made in a near-surgically clean production area under the exacting requirements of our Intensified Control and Reliability program.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

YOUR BEST SINGLE SOURCE FOR ALL MICRO-MINIATURE RELAYS

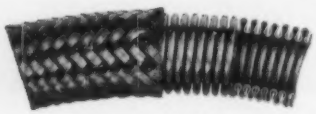
POTTER & BRUMFIELD

DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY • PRINCETON, INDIANA

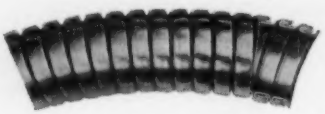
IN CANADA: POTTER & BRUMFIELD CANADA LTD., GUELPH, ONTARIO

Whatever your problem in flexible hose connections,

call the Man from Anaconda Metal Hose

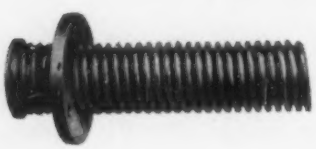


Seamless: Of tin bronze (98¾% copper, 1¼% tin)—also corrugated stainless steel—in sizes ⅛" through 4" I.D. For conveying fluids, chemicals, etc., under conditions of flexure or vibration and to allow for misalignment. Reusable (mechanical type), soldered or welded fittings.



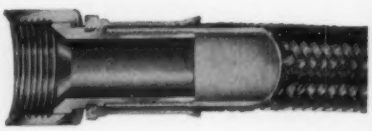
Stripwound: Constructed from brass, bronze, aluminum, galvanized or stainless steel. Sizes ½" through 8" I.D. A rugged type of hose for general service as steam, oil, water, particularly where the hose is handled manually. Fittings: soldered or heatproof (packed-on).

Type UI: Interlocked unpacked hose in galvanized steel, stainless steel, aluminum, etc. Sizes through 8" I.D. For ventilating ducts, dust collection, engine exhausts, exhausts at grinding machines, bottle chutes, drain lines, protective casing for flexible hose assemblies.



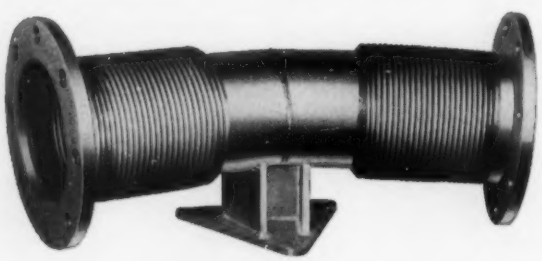
Diesel: Heavy-duty steel exhaust and air intake hose. Sizes 2" through 16" I.D. Designed for rugged, heavy-duty use. Helical corrugations with open or closed pitch. Also in stainless steel (type Y-21) for corrosive applications.

Flexpipe: Takes up travel in piping, connects misaligned ports, dampens noise and vibration in piping. Standard sizes and lengths. Available in bronze, stainless steel, steel; in sizes ¼" through 16" I.D. with NPT fittings, flanges or welding nipples.



Teflon* Anaconda flexible connectors of Teflon with stainless steel wire braid for use with pipe sizes from ⅛" through 1¼". Available in a wide variety of standard hose assemblies complete with fittings.

*Teflon is a DuPont trademark for its fluorocarbon resins.



AX Tubing: Large diameter tubing for big, tough jobs. Available in Type 321 Stainless Steel, and other metals and alloys. Sizes from 4½" through 14" I.D. Designed to handle axial and lateral movement—while conveying large volumes of liquids or gases—for bulkhead seals, etc.

FREE TECHNICAL SERVICE. Anaconda Metal Hose specialists are constantly working with design engineers on special flexible connectors and hose to meet new problems. Having broad experience working in stainless steel, other steel alloys, Monel, copper alloys, aluminum, and Teflon, they can save you considerable time and money in designing the flexible connector best suited for any of your jobs.

Our specialists are available to you through Anaconda Metal Hose representatives in leading cities—see listing "Hose-Metal" in the Yellow Pages. Or write: Anaconda Metal Hose, P.O. Box 791, Waterbury 20, Conn.

59129 Rev. L.

ANACONDA® METAL HOSE

CIRCLE 50 ON READER SERVICE CARD

PRODUCT ENGINEERING HORIZONS

JANUARY 9, 1961

DOUBLE STANDARD?

West Germany has been the spectacular industrial nation since World War II. Her recovery has been little short of miraculous. Our money helped. Modern equipment to replace bombed-out and reparations-lost units helped. German initiative and drive helped.

But never underestimate the value of the Verein Deutscher Ingenieure. Here is a single, over-all—hence powerful—engineering organization that is a major voice in German industry. The VDI has established and maintains Deutsche Industrie Normen (DIN), the single German standards that are respected and followed all over Europe.

For contrast, look at our standards, sponsored by all sorts of organizations for all sorts of reasons. We can rarely agree on single national standards—our company, our industry, our society knows best. American emphasis on individuality here shows at its strongest, as does our pride in independence. "We'll do it *my* way, with *my* committee, to *my* specs"—or the individual feels he has lost face.

All of us are willing to fight for our independence, anytime, while the European has for centuries accepted regimentation. This basic difference spills over into design, hence into standards.

Let's take fasteners as a case in point. Some years back there was a concerted effort to reduce the number of types and sizes. This resulted in a cut from 250,000 to about half that. Now, according to Industrial Fasteners Institute, there are about half a million.

Some of these are required for versatility in design, of course, but many are not. Many are required because of our complex standards system. We have national standards, industry standards, company standards and military specifications as four basic classes. One recent listing breaks these up in turn into no less than 15 groups: AAR, ABS, AMS, API, ASA, ASTM, AF-Navy, EEI, IFI, Lloyd's, NAS, NBS, SAE, Federal, MIL.

Granted that these are all well-meaning and hard-working groups—isn't it a little overdone? Couldn't we be satisfied with a far smaller number? Couldn't the railroads and the automotive people agree, for example?

Complexity is just a four-syllable word for costs. And standards are just one example of the American itch for proliferation. We are never content with one of anything—automobile, home, church, potted chicken or chick. In industry, we strive for two plants, two committees, and such an extensive executive structure we must have grades of vice-presidents.

There's an old story that sums up the situation. An Englishman, a German and an American were shipwrecked on an uninhabited island. The German promptly dug up roots and began working with them to develop a substitute for beer. The Englishman trapped several local goats to see what he could develop as an ersatz beef. But the American started a Society of Shipwrecked Sailors and got himself elected president.

"THE SOVEREIGN OF THE SEAS" — from the collection of the Seamen's Bank For Savings in the City of New York

SETTING SAIL INTO THE SEA OF SYNTHETIC FELTS?

. . . Let Troyfelt help you plot your course

TROY's only business is in the synthetics—Dacron,® Orlon® and combinations. Moreover, TROY specializes in non-woven felts, having pioneered in the development of the non-woven process.

What is the advantage of TROYFELT? Simply this: no binder is used. Eliminating chemical and fiber binders results in *far greater design versatility*. We can give you outstanding abrasion, heat and chemical resistance. Higher insulation. Greater filtering ability. Just the thickness, density, permeability or weight you want. You tell us what properties you're looking for — and in most cases we can match your needs precisely.

See how you may improve your present products . . . solve an operating problem . . . or even come up with an entirely new product. Details . . . just drop us a note. We'll send our most recent technical bulletin and sample of various blends of TROYFELT.

TROYFELT *. . . by the pioneers in non-woven synthetic felts*

INDUSTRIAL PRODUCTS DIVISION • TROY BLANKET MILLS

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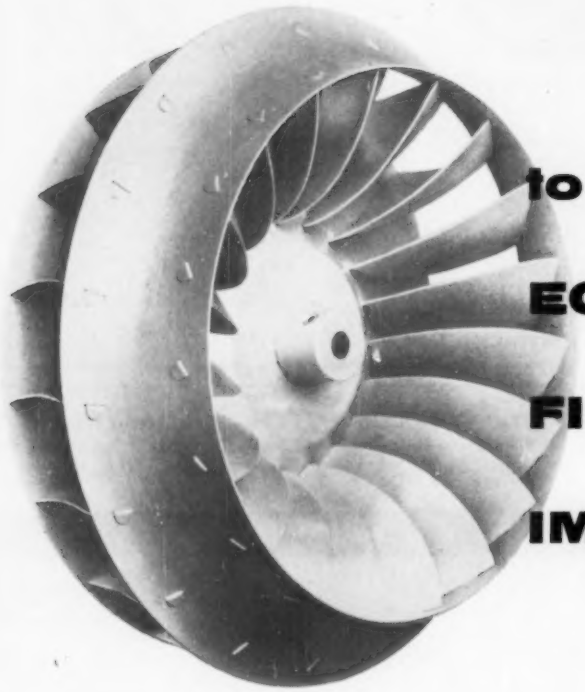

to move air— EQUATIONS FIND THE RIGHT IMPELLER

Once the airflow, static pressure and rpm are determined, just a few simple calculations will show the type and size of impeller needed. This sharply reduces time spent searching through manufacturers' catalogs.

J M WATSON
The Torrington Mfg Co
Torrington, Conn

After you calculate the specific speed needed, it's easy to settle on the type of impeller for a particular application. But making the final specific choice with only this information involves a long search of manufacturers' catalogs. However, most of this waste time can be eliminated if you also know the required impeller size; and the method described in this article shows how to find it.

All you need are a few simple calculations involving coefficients of pressure and flow. Typical values for these factors, for all major impeller types, are listed in Table II.

IMPELLER TYPES

Table I shows the three major impeller types, together with subgroups and typical applications. The most frequently used commercial types are: forward-curved-centrifugal, mixed-flow, and propeller-type-axial impellers. Forward-curved centrifugal impellers are divided into two subgroups—normal blade area, where total blade surface is about equal to peripheral surface of the impeller; and high blade area, where total blade surface is 30 to 40% greater than peripheral area. This division is important because of the effect of blade surface on pressure and flow coefficients. Propeller fans are subdivided into groups with high, medium, and low pressure coefficients. Vane-axial and tube-axial impellers are usually designed to customers' specifications, and so should be selected by working directly with the manufacturer.

continued, next page

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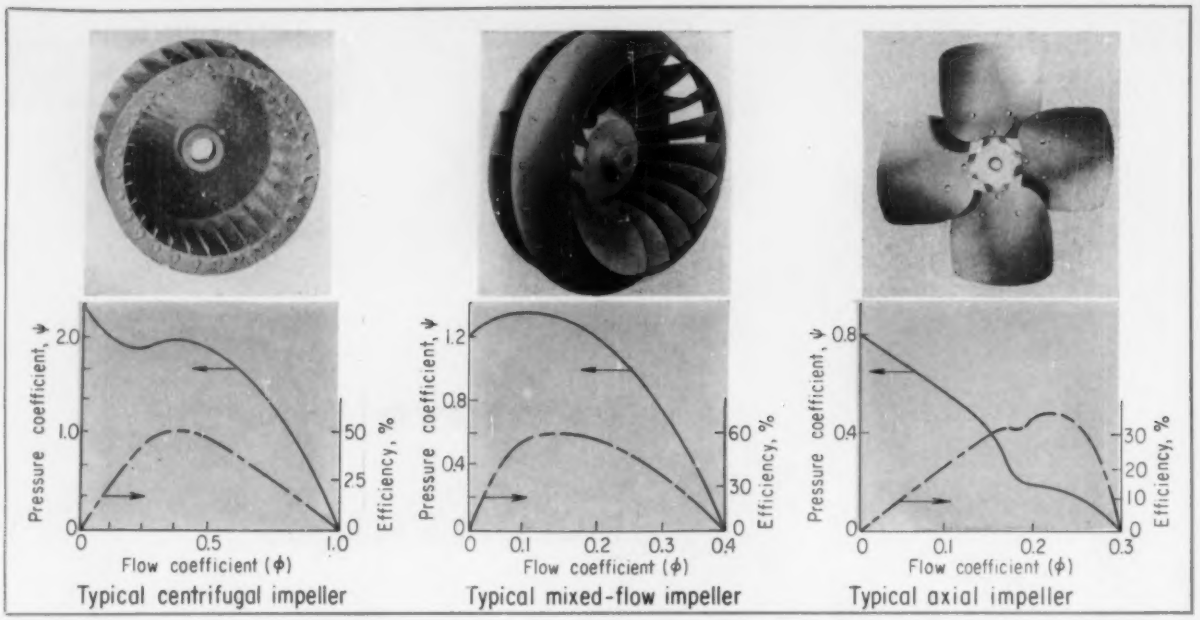


THREE BASIC IMPELLERS—Solid curves relate pressure coefficients to flow coefficients for typical impellers of each type. Dotted curves indicate relative efficiency.

Table I—Characteristics of Various Impeller Types

Type				Pressure coef ψ	Flow coef ϕ	Typical applications
Centrifugal impellers	Forward normal curved	High blade area		1.5–2.0	0.20–0.75	Room air conditioners Central air conditioning and heating Electronic-equipment cooling
		Normal blade area		1.0–2.0	0.15–0.65	
	Radial blade			1.0–1.4	0.002–0.09	Washing machines Clothes dryers Assorted household appliances
	Backward curved			0.60–1.10	0.09–0.30	Industrial exhaust systems Electronic-equipment cooling
Mixed-flow impellers				0.60–1.10	0.10–0.25	Room air conditioners Roof ventilators
Axial impellers	Vane axial			0.20–0.60	0.10–0.40	Aircraft air conditioning Pressurizing aircraft compartments Shipboard air conditioning
	Tube axial			0.10–0.30	0.10–0.40	Electronic-equipment cooling Aircraft air conditioning
	Propeller	High ψ		0.15–0.20	0.25–0.40	Air conditioning condensing units
		Med ψ		0.10–0.15	0.15–0.35	Light industrial exhaust fans
		Low ψ		0.05–0.10	0.10–0.25	Unit and space heaters, Air circulators Assorted portable appliances

HOW TO CHOOSE

Here is the simple step-by-step procedure for finding the specific impeller needed for any application.

Find the right type

List your application requirements: airflow Q, in cfm; static pressure p_s, in inches of water; and impeller speed, N, in rpm. Airflow rate is determined by established heat-transfer rates and unit performance required for the application. Static pressure is determined by air-path configuration, coil resistance, filters, louvers, and other elements in the flow system. Impeller speed is determined by the choice of motor (standard four- and six-pole shaded-pole and split-capacitor types are available) and also by the drive—direct or belt.

Calculate specific speed. Use equation:

$$N_s = \frac{NQ^{\frac{1}{2}}}{p_s^{\frac{3}{4}}}$$

or find specific speed, using nomograph on page 56.

Table II–Performance Data for Impellers

Type			Specific speed N_s x 1000 (Peak efficiency at widest part of bar)	Typical ψ	Typical ϕ
Centrifugal impellers	Forward curved	High blade area		1.70	0.254
		Normal blade area		1.40	0.176
	Radial blade			1.0 – 1.4	0.002-0.09
	Backward curved			0.60–1.10	0.09-0.30
Mixed–flow impellers				1.00	0.112
Axial impellers	Vane axial			*	*
	Tube axial			*	*
	Propeller	High ψ		0.175	0.263
		Med ψ		0.125	0.250
		Low ψ		0.075	0.238

*Wide deviation possible within range

6 8 10 20 30 40 60 80 100 200 300

Check the tables. Table II shows the type (or types) of impellers that operate at high efficiency at the calculated specific speed. The widest portion of the bar indicates the point of peak efficiency. If more than one impeller type is appropriate, base your final selection on such other factors as cost, size and shape of space available, and nature of flowpath. Generally, one type of impeller will be a clear choice for a particular application.

Find the right standard diameter

Using appropriate pressure coefficient ψ, from Table II, calculate theoretical impeller diameter from this equation:

$$D = \frac{1.53 \times 10^4}{N} \sqrt{\frac{p_s}{\psi}}$$

(For derivation of this equation and the others that follow, see p 57.)

Consult a catalog to find a standard diameter that most closely matches the theoretical diameter you have calculated. Use this value for the remaining steps.

Find other dimensions, if needed

Propeller type–find the pitch angle by substituting in this equation (see Table II for flow- coefficient ϕ):

$$\alpha = \sin^{-1} \frac{350\,Q}{\phi_1 N D^3}$$

Forward-curved centrifugal or mixed-flow impeller–find impeller width:

$$W = \frac{175\,Q}{\phi_1 N D^2}$$

Radial-bladed or backward-curved centrifugal impeller–consult a manufacturer's catalog for additional information, because they may be carried as special products.

Make the final choice

Consult a manufacturer's catalog for final selection. It should be easy because type and approximate size are known.

SYMBOLS

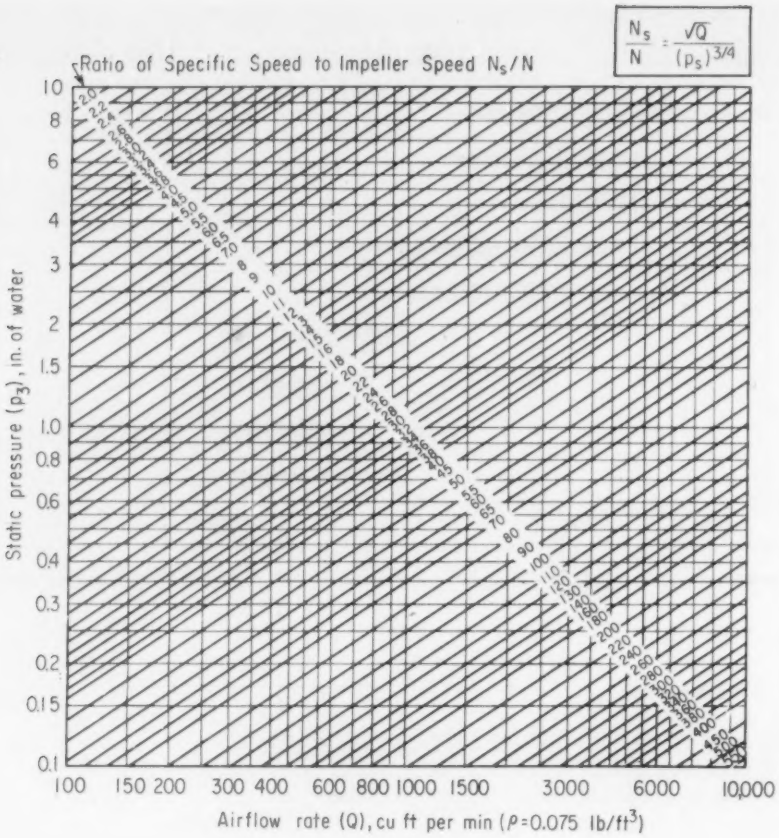
- N_s —specific speed
- N —impeller speed, rpm
- Q —airflow rate, cfm
- p_s —static pressure, in. water
- ψ —pressure coefficient
- ϕ —flow coefficient
- g —acceleration of gravity, ft/sec/sec
- ρ —weight density of air, lb/cu ft
- U_t —blade tip velocity, ft/sec
- D —impeller diameter, in.
- V_o —airflow velocity, ft/sec
- ΔA —cross-section of airflow, sq ft
- α —fan pitch angle, deg
- K —constant for given class of fans
- W —width of impeller, in.

OTHER APPLICATION REQUIREMENTS

Although this selection method has been presented with airflow rate, static pressure and rotational speed as the application requirements, it is not limited to impeller selection where these are the only known quantities. For example, if you must use either a particular type of impeller or a particular impeller diameter and you must find the best impeller, the selection procedure described above can still be used.

If diameter is known, for instance, the equation for D can be rearranged to solve for one of the other factors.

Even where there are too many unknowns you can accurately estimate a solution by varying a particular parameter within reasonable limits and calculating the other parameters until a satisfactory impeller is found. After a little practice, solutions can be found in this



Alternate method for finding specific speed. Because the result (diagonal column) is a ratio of $\frac{N_s}{N}$, mutiply by impeller speed N to get specific speed, N_s.

manner almost as quickly as if all the requirements were given.

HOW THIS METHOD WORKS

Two typical problems will show how simply and quickly you can find the right impeller for a given set of conditions.

Example I

Assume the following requirements:

$Q = 500$ cfm
$p_s = 0.10$ in. of water
$N = 1550$ rpm

To find the impeller type required, calculate specific speed:

$$N_s = \frac{NQ^{1/2}}{p_s^{3/4}} = \frac{(1550)(500)^{1/2}}{(0.10)^{3/4}} = 194{,}500$$

In Table II, the most efficient impeller for a specific speed of 194,500 is a propeller with a low-pressure coefficient.

Table II gives 0.075 as the typical pressure coefficient for the low-ψ propeller. Diameter then is calculated:

$$D = \frac{1.53 \times 10^4}{N}\sqrt{\frac{p_s}{\psi}}$$

$$D = \frac{1.53 \times 10^4}{1550}\sqrt{\frac{0.10}{0.075}}$$

$$D = 11.4 \text{ in.}$$

To find fan pitch angle, find a standard diameter closest to 11.4 in. One catalog lists a standard fan with an 11-in. dia.

Table II gives 0.238 as typical flow coefficient, ϕ, for the low-ψ propeller. Pitch angle α then is:

$$\alpha = \sin^{-1}\frac{350Q}{\phi_1 ND^3}$$

$$= \sin^{-1}\left[\frac{(350)(500)}{(0.238)(1550)(11)^3}\right]$$

$$= \sin^{-1}(0.357)$$

$$\alpha = 21°$$

The catalog lists performance data for 16° and 24° pitch angles for the 11-in.-dia fan. The 24° fan delivers 660 cfm at 0.10 in. of water and 1550 rpm, which is higher air delivery than necessary. With 16° pitch angle, the fan delivers about 515 cfm at 0.10 in. of water and 1550 rpm. This is very close to the requirements, so final selection is an 11-in.-dia., low-ψ propeller fan with a 16° pitch angle.

Example II

Assume the following requirements:

$Q = 100$ cfm
$p_s = 0.25$ in. of water
$N = 1000$ rpm

The specific speed is

$$N_s = \frac{1000(100)^{1/2}}{(.25)^{3/4}} = 28{,}200$$

Table II indicates that any of four impeller types may be efficiently applied:

DERIVATIONS OF KEY EQUATIONS

Pressure and Flow Coefficient

Here's how the coefficients listed in Table II were calculated.

Pressure coefficient ψ, a dimensionless quantity, is the ratio of potential energy developed by an impeller to pressure energy corresponding to blade-tip velocity:

$$\psi = \frac{2gp_s}{\rho U_t^2} \quad (1)$$

It can also be expressed as:

$$\psi = \frac{2.35 \times 10^8 p_s}{N^2 D^2} \quad (2)$$

By rearranging, an equation for impeller diameter becomes:

$$D = \frac{1.53 \times 10^4}{N} \sqrt{\frac{p_s}{\psi}} \quad (3)$$

Flow coefficient ϕ, also a dimensionless quantity, is the ratio of airflow velocity to blade-tip velocity:

$$\phi = \frac{V_a}{U_t} \quad (4)$$

In order to maintain a uniform approach for all axial- and centrifugal-impeller types, ΔA is defined as $\pi D^2/4$. Therefore flow coefficient can be expressed:

$$\phi = \frac{700Q}{ND^3} \quad (5)$$

where $Q = \Delta A \times V_a$.

Blade pitch angle and impeller width

Pitch angle can be determined by:

$$\sin \alpha = K\phi$$

This equation is empirical, and holds true only for flow rates from 70 to 100% of maximum flow. But for this range of flow rates, propeller fans are most efficient and are most effectively used. If, in the equation

$$\frac{\sin \alpha_1}{\phi_1} = \frac{\sin \alpha_2}{\phi_2} \quad (6)$$

the ratio $\sin \alpha_1/\psi_1$ for a particular fan is known, the sine of the pitch angle α_2 of another fan of the same class can be found by finding its flow coefficient, ϕ_2. If, for example, a pitch angle of 30° is assigned to α_1, then $\sin \alpha_1 = 0.5$. In Table II, flow coefficients are given out for fans of 30° pitch in each class of propeller fan. Therefore, pitch angle for any fan can be calculated from the application requirements, diameter, and flow coefficient, by substituting the value of ϕ from Eq (5) for ϕ_2 in Eq (6).

$$\sin \alpha_2 = \frac{350Q}{\phi_1 ND^3} \text{ or} \quad (7)$$

$$\alpha = \sin^{-1} \frac{350Q}{\phi ND^3} \quad (8)$$

For centrifugal and mixed-flow impellers, width of the impeller must be known. The ratio of width to diameter is proportional to the flow coefficient:

$$\frac{W}{D} = K\phi \quad (9)$$

where K is constant for a given impeller design $\frac{W}{D} = 0.25$ is assumed, and corresponding values of ϕ_1 are determined in Table II for each class of impellers. Substituting Eq (5) in Eq (9) gives:

$$W = \frac{175Q}{\phi ND^3} \quad (10)$$

- Forward-curved centrifugal impeller of high blade area
- Forward-curved centrifugal impeller of normal blade area
- Backward-curved centrifugal impeller
- Mixed-flow impeller

Typical pressure coefficients from Table II for these types of impellers start from 1.7 for high-blade-area forward-curved centrifugals and drop down to 1.0 for mixed-flow impellers.

Because diameter is an inverse function of pressure coefficient for a fixed speed and a fixed static pressure, it is evident that for a higher pressure coefficient the impeller diameter will be smaller. Thus, a forward-curved centrifugal impeller of high blade area will require the smallest impeller diameter in this particular application, and is the most desirable.

The required diameter will then be:

$$D = \frac{1.53 \times 10^4}{1000} \sqrt{\frac{.25}{1.7}} = 5.85 \text{ in.}$$

The closest diameter listed in the manufacturer's catalog for a standard forward-curved centrifugal blower wheel of high blade area is $D = 5\frac{13}{16}$ in.

Table II indicates 0.25 for a typical value of ϕ for a forward-curved centrifugal impeller of high blade area, resulting in a blade width:

$$W = \frac{(175)(100)}{(.25)(1000)(5.59)^2}$$

$$W = 2.25 \text{ in.}$$

The closest standard width listed in the catalog is $W = 2\ 16/32$ in.

The catalog performance-curve for this particular impeller shows it will deliver 98 cfm against a static pressure of 0.25 in. of water when operated at 1000 rpm. A slight increase in speed, such as from 1000 to 1020 rpm, will raise the airflow rate to at least the 100 cfm originally required. This increase in speed is well within normal motor capabilities, so the final selection is a forward-curved centrifugal impeller of high blade area, $5\frac{13}{16}$ in. dia and $2\frac{1}{2}$ in. wide.

For REPRINT of above article, just check P78 on one of the Reader Service cards found in this issue.

EDITOR'S NOTE: For more information about fans, see:

Mixed-flow Impellers Enter Air-moving Field, Jan. 5 '59, p. 56. Author tells how these impellers, introduced for air conditioners, outperform older types when pressures are too high for axial fans and too low for centrifugal blowers.

Guide to Fan Selection, April 28 '58, p 92 discusses use of multirating tables, selecting motor size, regulating volume of air and fan noise, and reviews basic fan laws.

How You Can Measure Airflow, June '57, p 145, describes practical test setups for determining rate and pressure.

Fan Cooling—Influence of Altitude, June '56, p 198. How variations in air density and temperature affect heat transfer in cooling systems from sea level to 15,000 ft.

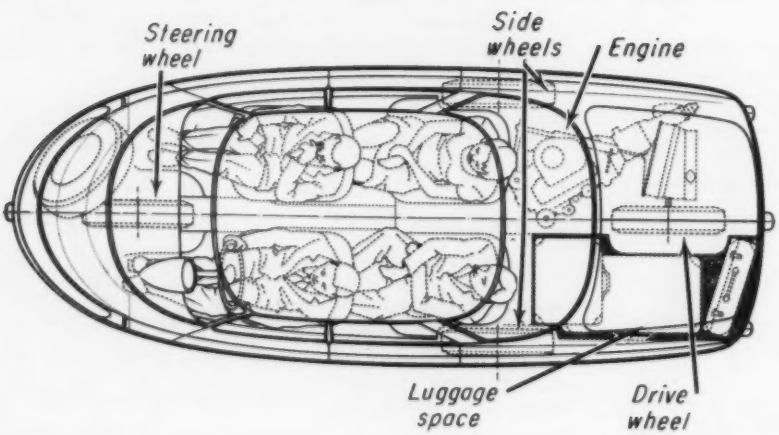
PRODUCT DESIGNS

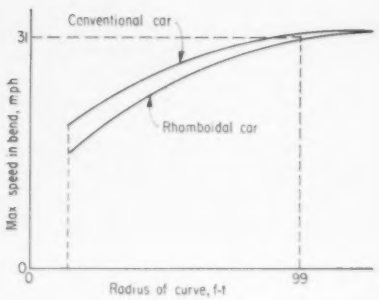
AT TURIN AUTO SHOW

Italian designers continue to buck tradition

Diamond pattern of wheels, driver's seat ahead of front wheels, and a production car with pancake engine and front-wheel drive—these were among the surprises shown by Lancia, Farina and Ghia.

FARINA X





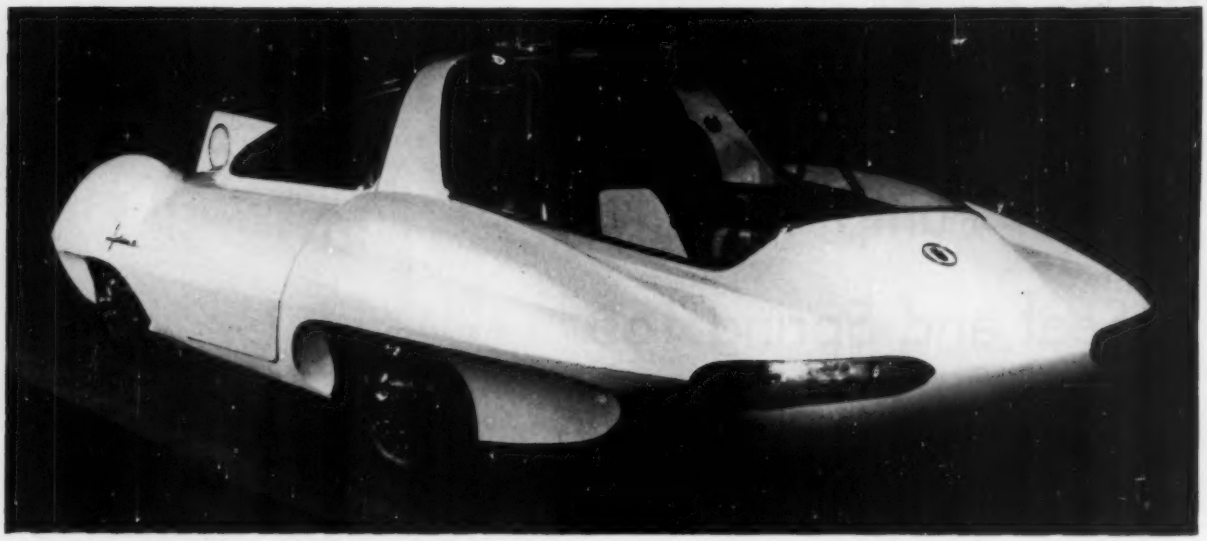
DIAMOND PATTERN (rhomboid) of wheels allows more tapering of body for better aerodynamics. Shape has wind-resistance coefficient of 0.2, low for a nonracing car. Designers estimate that 88-mph top speed is 12 mph better than that possible with standard shape, and fuel consumption of 39 mpg at 60 mph is a 20 to 40% improvement.

The single front wheel steers; single rear wheel does the driving. Weight distribution among the wheels is: front, 37%, side, 13% each, rear, 37%. With less than the normal 50% weight on driving wheels, full engine torque cannot be used under 17.4 mph without spinning the wheels. Conventional car can use full torque at 13 mph.

Center position of front wheel enables car to enter parking space frontwards if curb is low enough to allow car body to overhang sidewalk. Farina's X can also leave frontwards from a smaller space than a conventional auto.

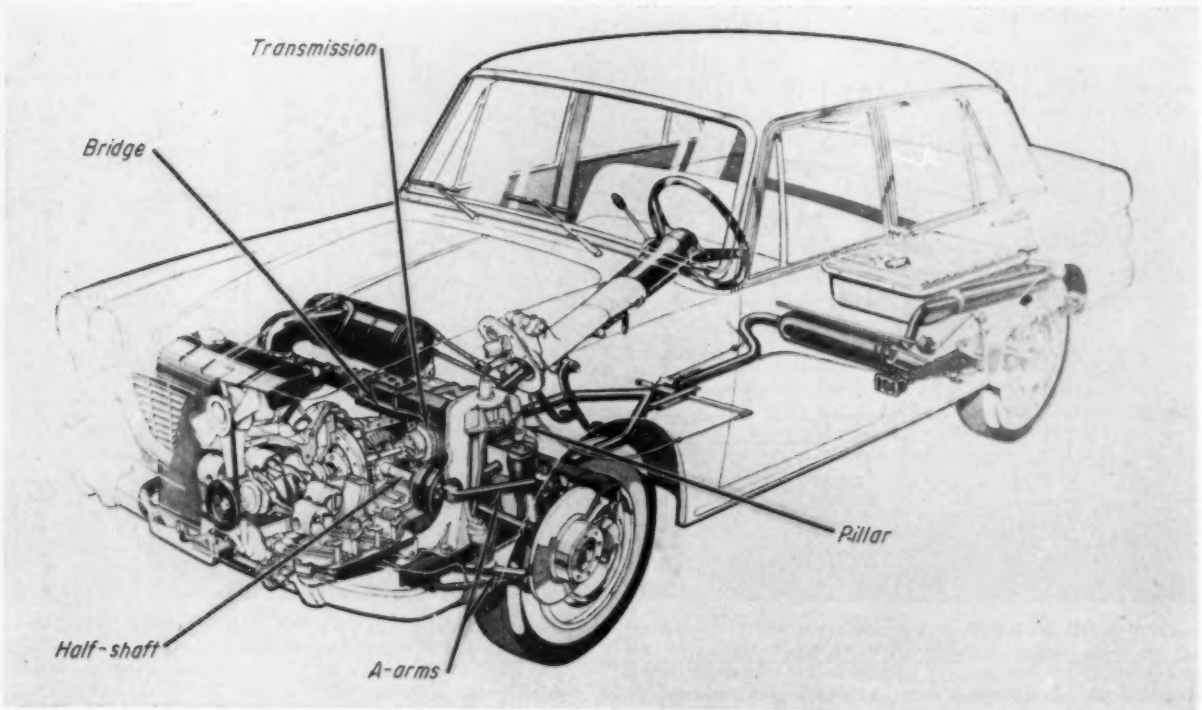
Although this design makes parking easier, it reduces road performance. Especially in low-speed turns, the X cannot take curves as fast as conventional cars without breaking loose (chart above).

Location of 1089 cc (66.4 cu in.) engine on right side in rear balances weight of driver on left.



GHIA SELENE II

LONESOME DRIVER sits alone, ahead of the front wheels. Two passenger seats behind him face the rear. Most rear-engine cars suffer from too much weight on the rear wheels, but this Ghia has seats placed far forward, giving perfect 50-50 weight distribution.



LANCIA FLAVIA

FRONT-WHEEL DRIVE is through two half-axles from differential set between engine and transmission. Subframe, which bolts to front of main chassis in six places, carries the engine transaxle unit and suspension.

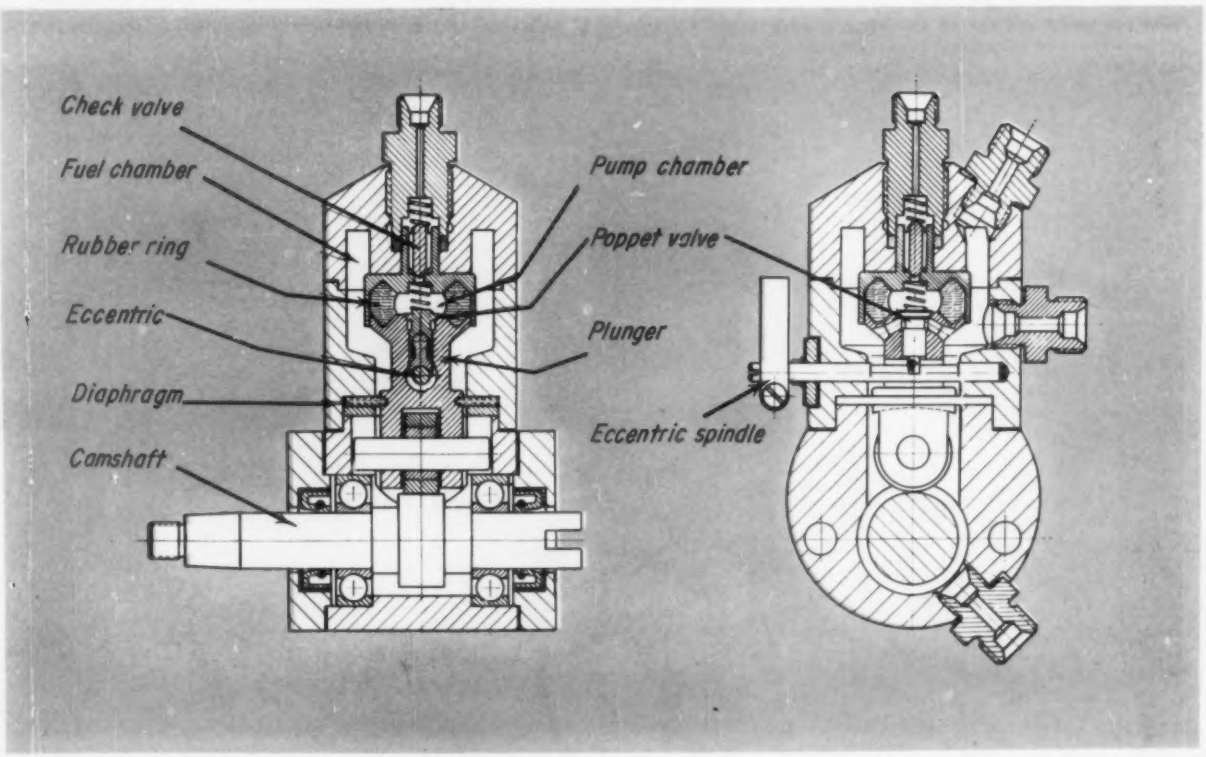
Wheel location is by upper and lower A-arms. Single semielliptical spring rides transversely on a bridge between two cast-aluminum pillars which bolt to subframe.

Aluminum in the power unit helps cut down overweight in the front. The vertically split block, heads, pistons and transmission, and differential case are all of aluminum.

Four-cyl opposed engine with dual camshafts develops 78 hp from 1.5-liter (91.5 cu in.) displacement.

Rubber Pump Wall Is Seal and Spring Too

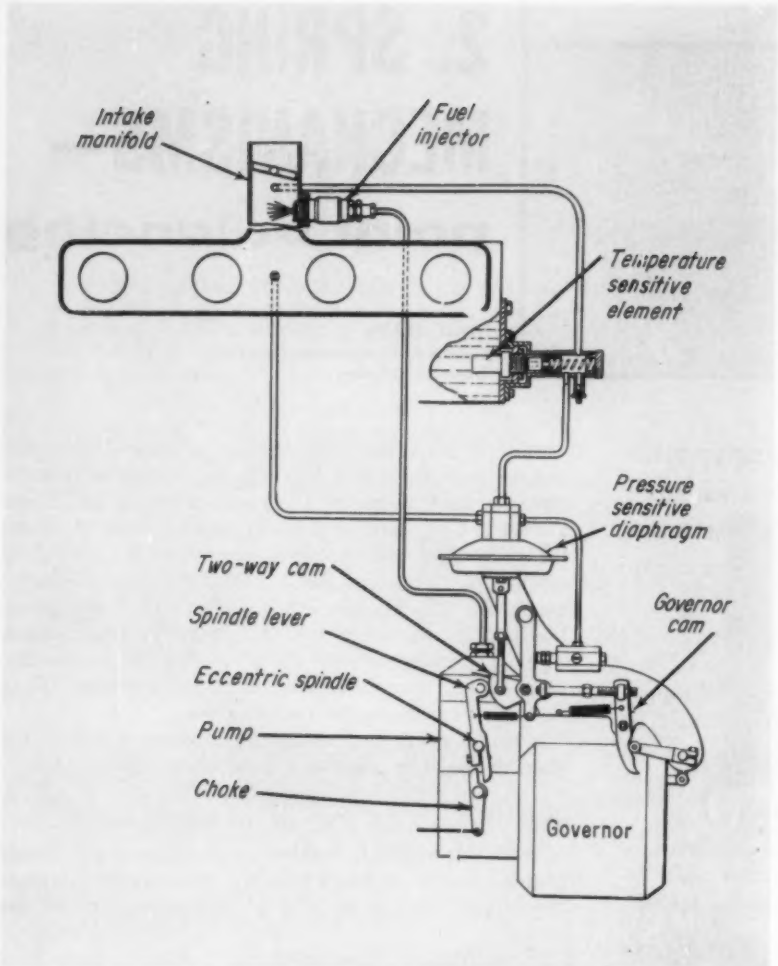
This multipurpose ring eliminates costly machining in fuel injection pump. Speed of the engine and manifold pressure set correct fuel-flow rate for any load.



SYNTHETIC RUBBER RING combines three functions: 1) it seals pump cylinder with no need for expensive machining; 2) serves as a spring to keep plunger roller follower in contact with cam; 3) pumps fuel when compressed by plunger.

Fuel enters the pumping chamber through a poppet valve. Stem of the poppet rests on an eccentric spindle, which thereby controls the position of the valve at the start of each pump stroke. Seat for this valve is built into the plunger crown. As the plunger rises, fuel is forced back out of the pumping chamber until the seat contacts the poppet valve and shuts off the fuel inlet. The higher the initial position of the poppet, the later this contact occurs, which means less fuel is pumped. Once the valve has seated, the valve and plunger rise together, compressing the rubber ring and forcing fuel through the check valve to the injector.

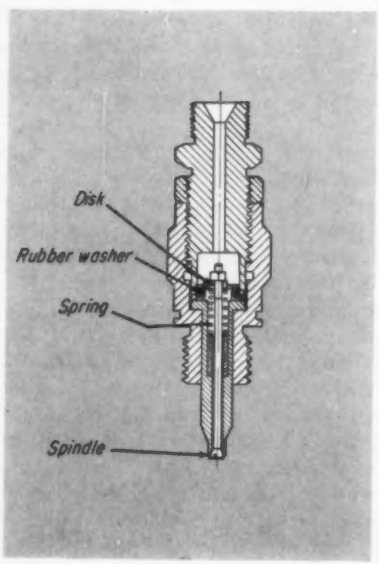
The cam that drives the reciprocating plunger has one lobe for each cylinder, and operates at one-half engine speed. Camshaft housing is oil-filled and separated from fuel chamber by diaphragm. Short plunger stroke (0.015 in.) and large clearance between plunger and housing permit use of simple diaphragm seal. Position of the eccentric spindle, hence the amount of fuel pumped, is controlled by two sensing elements: a speed-sensitive governor, and a pressure-sensitive diaphragm.



FUEL METERING is controlled by the diaphragm, which reacts to pressure changes in the intake manifold; and the governor, which reacts to changes in engine rpm. Output motion from these two is transmitted by cam action to the eccentric spindle, which adjusts the amount of fuel pumped during each cycle.

A two-way cam transmits motion from the two control elements to the spindle lever. The diaphragm unit imparts vertical motion; the governor, horizontal. In operation, either or both of these motions are used to adjust fuel supply to engine load.

A temperature-sensitive element in the cylinder head automatically adjusts the fuel-air mixture to produce fast warmup. At low engine temperature this element bleeds air to the intake manifold, which increases idling speed; and increases air pressure in the diaphragm, causing it to enrich the mixture. As engine warms up, the element restores normal idling speed.



INJECTION NOZZLE receives fuel from pump and discharges it into the intake manifold. Fuel enters the nozzle through angular drillings in a disk on the spindle, and fills the housing. Injection pressure moves the spindle off its seat, permitting fuel to be discharged. Greater pressure produces greater spindle movement until the disk contacts a rubber washer. This reduces the downstream disk area contacting the fuel, and builds up greater pressure on the other side of the disk. Further spindle travel deforms the rubber washer, which then acts as a high-rate spring. This provides snap-action cutoff when fuel pressure drops.

PS . . . Fuel-injection system can be added to existing engines without extensive modifications. Indirect fuel injection uses single injector nozzle located in the intake manifold at a point common to all cylinders. Pump can supply fuel for injection systems on engines up to 4 liters, running at speeds up to 6000 rpm. Tests on a 1700-cc engine showed improvements of 8% in fuel consumption, 10% in maximum speed and 25% in acceleration when injection system replaced carburetor. Pump and injection system is produced by Simms Motor Units Ltd, Finchley, London, Eng.

nine lectures on MECHANISMS

1...SPRING MECHANISMS—force analysis
2...SPRING MECHANISMS—point balancing
3...SPRING MECHANISMS—continuous balancing
4...POWER CYLINDER MECHANISMS—full stroke
5...POWER CYLINDER MECHANISMS—intermediate positions
6...FEEDER MECHANISMS—types
7...FEEDER MECHANISMS—applications
8...FEEDER MECHANISMS—angular motions
9...FEEDER MECHANISMS—curvilinear motions

2. SPRING MECHANISMS— point balancing

KURT HAIN
Institute For Fundamental Research
Brunswick, Germany

Graphical methods show how springs with plain lever mechanisms can balance load moments at four precision points. For more than four points, such levers allow only approximate balancing.

Design of spring-controlled mechanisms can be simplified by reducing the number of variables. For example, in Fig 1(A) the balancing moment is:

$$m_F = rbc \sin \phi \left(1 - \frac{a}{\sqrt{r^2 + b^2 - 2rb \cos \phi}}\right)$$

And if the four factors r, b, a, and c are considered as variables, four equations with four unknowns must be solved to determine the balancing moments m_{F1} through m_{F4} for the various displacement angles ϕ_1, through ϕ_4.

Now, to simplify the approach, consider the balancing moment m_F and load moment m_W separately, and plot moment curves as shown in Fig 1(B). The balancing moments for a series of springs and lever arms can be drawn and these can then be matched to any given load-moment curve. The balancing-moment curve which most nearly coincides with the load-moment curve will then give the desired set of dimensional values.

One way to get a theoretically exact balance is shown in Fig 1(C), where factor a in the above equation is zero, with the result:

$$m_F = rbc \sin \phi = W\rho \sin \phi'$$

In this arrangement $r = c$, and $\phi = \phi'$; therefore the above equation reduces to:

$$m_F = r^2 c = W\rho = m_W$$

This type of solution is satisfactory only for load moments that vary as a sine function, and where a continuous balance is required.

However, continuous balance is not always necessary. Sometimes, a balance at two, three, or four points, is sufficient. Where balance is required at only two points, this can be accomplished by a layout as in Fig 2(A).

First step is to determine max allowable stress in the spring, the corresponding force P_1, and spring elongation f, which gives:

$$h_1 = m_{W1}/P_1$$

With h_1 as a radius, then draw an arc about O. Any two rays O1 and O2 are then drawn from O to enclose between them the angle ϕ, and on these lines points A_1 and A_2 are located at any chosen but equal distances from O. From the point A_1 a line is drawn tangent to the arc whose radius is h_1, and on this line a point S is chosen arbitrarily, but in the vicinity where it is desired to attach the spring. Furthermore, point S is such that, when a circle is drawn about it passing through A_2 to cut SA_1 at T, the line segment TA_1 is approximately equal to the desired spring elongation f between the two positions.

Now by using the spring-rate constant, $c = P/f$, the moment-arm h_2 in position 2 is calculated from:

$$h_2 = m_{W2}/P_2$$

where $P_2 = P_1 - cf$, and m_{W2} is given.

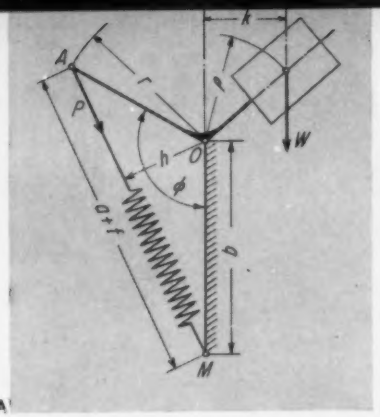
With this length h_2 another arc is drawn about O, and to this a tangent is drawn from A_2. This tangent intersects the tangent from A_1 to h_1 at M, the pivot point for the spring.

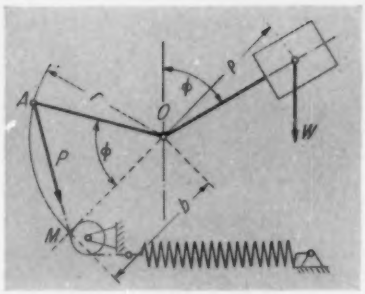
If the arbitrarily chosen point S lies very far from point M, the above procedure must be repeated to obtain a more favorable location. This construction shows that for every pair of points A'_1 and A'_2 arbitrarily chosen on the rays 1 and 2 from center O, an intersection point M' will all lie on a curve k. The length of the lever arm for the spring must not be less than the smaller radius h_1 or h_2, because then no tangent could be drawn to the circles from points A_1 or A_2.

Analogous construction can be used to determine three balance points as shown in Fig 2(B). However, in this case the lever arm OA cannot be chosen arbitrarily. Instead, it is adjusted from OA' to OA'' until the tangents to the three arcs from OA intersect each other in one point as at M.

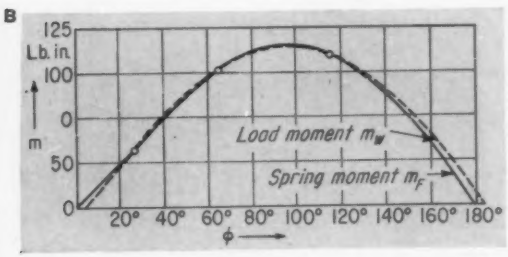
In Fig 3(A) it is desired to counterbalance given turning moments at three positions marked by rays O1, O2, and O3 with any desirable radius $OA_1 = OA_2 = OA_3$. To simplify construction M can be chosen along the extension of A_2A_3, so that $h_2 = h_3$ and the interval $A_2A_3 = f_{23}$. The corresponding spring forces P_2 and P_3 can be found by dividing the given turning moments by the lever arm h_2, and with this information the spring curve, Fig 3(B), can be drawn, and the necessary spring rate c calculated.

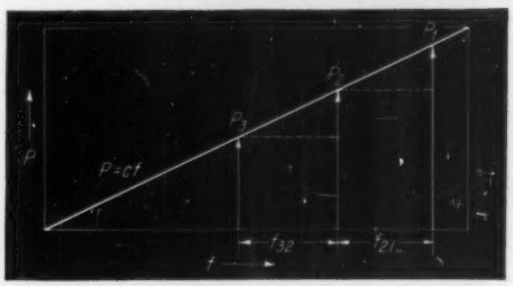
Next, in Fig 3(A) a point S is assumed within a short range of the expected position of the point M, and lying on line A_2A_3. With this as center a circle is drawn through



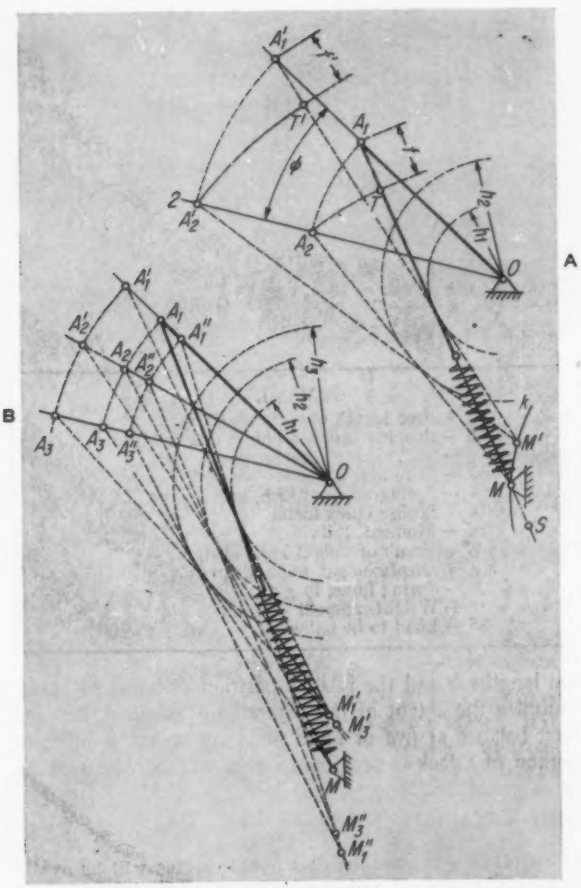


1 FOR BALANCING LOAD MOMENTS, key factors in an arrangement such as (A) are the lever-arm lengths and spring elongations. Choice of spring depends upon how closely the spring moments (B) are required to match the load moments. In (C) factor$_A$ equals 0, which makes it possible to balance load moments exactly.





3 GRAPHICAL SOLUTION of spring extensions required for a three-point balance (A) is developed in conjunction with layout of spring-rate curve (B).



2-A & B GRAPHICAL SOLUTIONS for a two-point and three point spring balance.

A_2 to cut line SA_1 at T. The interval TA_1 is then equal to the spring elongation f_{21} as the lever arm rotates from position OA_2 to OA_1.

This length f_{21} is then scaled off on the abscissa of Fig 3(B) to give P_1 as the ordinate for the value of the spring force at lever arm position OA_1. Now, the known load moment m_{w1} at position OA_1 can be divided by P_1 to give the moment-arm length h_1, which is then used to draw an arc about O. A tangent drawn to this arc from point A_3 will intersect line A_2A_3 at M to locate this point for the spring pivot. Here, again, the arbitrary selection of point S may require several trials to establish it near the desired point M with the correct elongation f_{21}.

The graphical solution of the spring rate can also be performed mathematically:

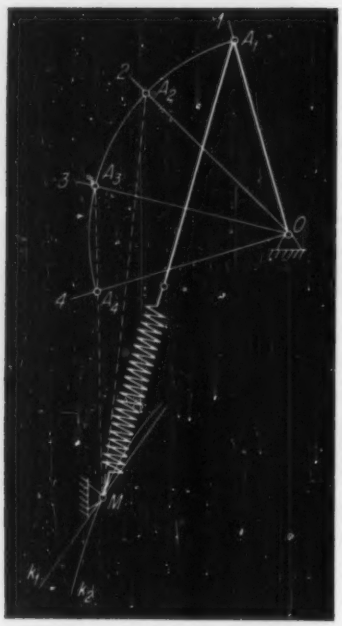
$$c = \frac{P_2 - P_3}{f_{32}} = \frac{P_1 - P_2}{f_{21}}, \text{ or } P_1 = \frac{f_{21}}{f_{32}}(P_2 - P_3) + P_2$$

The slope of the graph is a function of the length of the level arm OA—the longer arms require lower spring rate. In case construction of Fig 3(A) is such that $P_2 = P_3$, or $P_1 = P_2$, then spring rate $c = O$, an impossibility. Another point worth noting is that this construction can be simplified by making $h_1 = h_2$, or $h_1 = h_3$, which will establish either line A_1A_2 or A_1A_3 as the locus of possible points M.

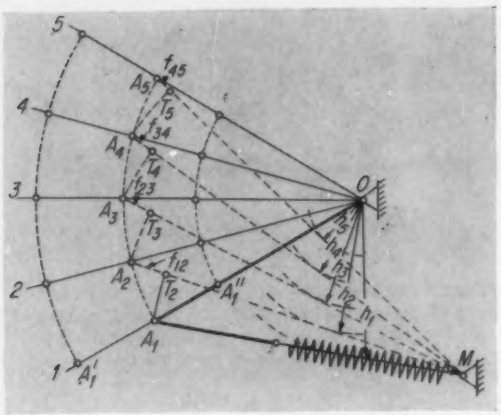
A four-position balancing mechanism can be designed in a similar manner, as shown in Fig. 4. The curve k_1 is drawn as the locus of all points M_{124}, which satisfy the

SPRING MECHANISMS

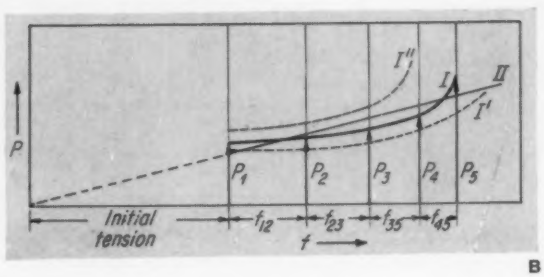
Continued



4 FOR A FOUR-POINT SPRING BALANCE, graphical solution is analogous to Figs. 2 and 3.

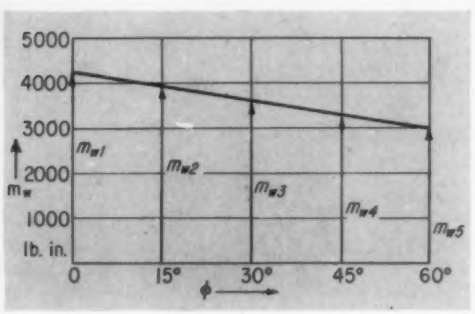


A



B

5 FIVE-POINT SPRING BALANCE (A) requires curved spring rates (B) in order to balance given load moments (C). This balance can be accomplished only approximately by a compromise spring rate (curve II) in (B).



C

three-point construction for rays O1, O3, and O4 for varying lengths of OA, and the curve k_2 as the locus of all points M_{234}. The desired point M is at the intersection of k_1 and k_2, and a spring designed in accordance with the above procedure will balance the given load moment in the four positions shown.

For a five-position balancing mechanism the construction is more complex, and generally it is not possible to obtain a perfect balance at all five points. For example, assume that load moments in Fig 5(C) are to be balanced with the spring mechanism shown in Fig 5(A), which is drawn in accordance with procedure described above. The required lever arms h_1 through h_5 establish the spring forces P_1 through P_5 and spring elongations f_{12} through f_{45}. From these it is possible to construct the spring-force curves in Fig 5(B).

In cases where such curves form a straight line, it is possible to design a spring to balance the load moments at five precision points. In the more likely event that the spring forces lie on a curve the requirements at the various positions shown in Fig 5 (C) must be compromised by a straight-line spring rate II. Variation in the arbitrary lever-arm lengths h and the relative position of point M could minimize the extent of the compromise required, but for exact balance at five or more precision points a different method of attack is preferable. This will be discussed in the next article.

SYMBOLS

a — Free length of spring, in.
b — Spacing between points O and M, in.
c — P/f, spring-rate constant
d — Wire dia, in.
h — Spring-moment arm, in.
k — Spring index factor
m — Moment, lb-ft
ρ — length of weight lever arm, in.
ϕ — Displacement angle, degrees
P — Spring force, lb
v — Weight-moment arm, in.
W — Load to be balanced

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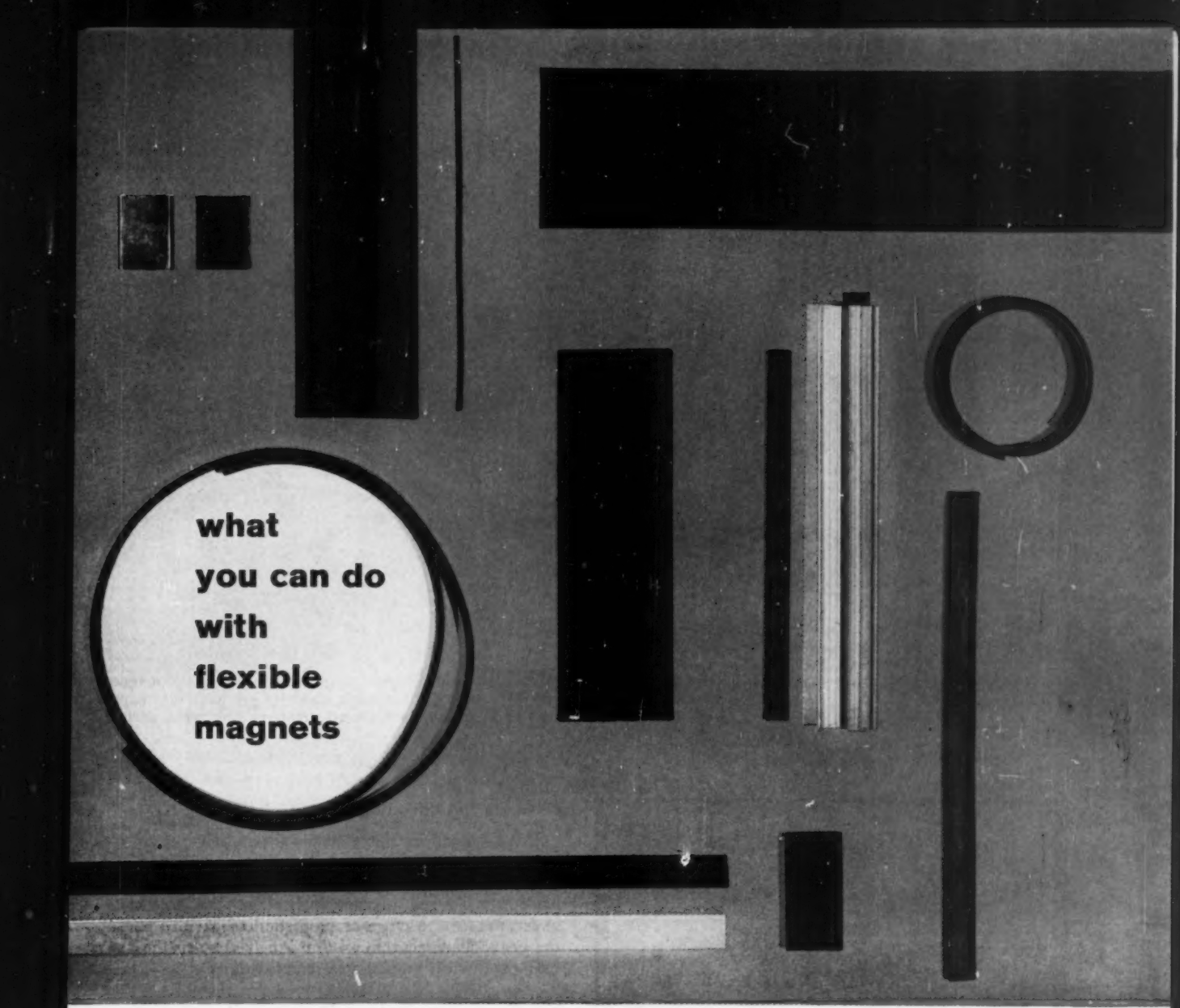

These rubbery materials are magnetized in bands, strips or almost any other pattern, and made in a variety of sizes, as the photo shows. Small rectangles, upper left, are backed with steel to enhance holding power. At right, center, is flexible magnet built into plastic gasketing extrusion.

Annesta R Gardner
Associate editor

Flexible magnets in a wide new range of materials—plastics as well as rubber—that can be bent or diecut to shape are now available for a host of new applications.

Rubber that incorporates magnetic particles has been on the market for some time. But the range of elastomeric materials containing such magnetizable particles as barium ferrite is now much wider, and production techniques have been improved to the point where permanent magnets—flexible and surprisingly strong—can be had. Furthermore, these materials, which were used at first only in closure mechanisms and coverings for machine pickup-rolls, are now being readied for products ranging from bicycles and toys to conveyor belts and oil filters. Electrical as well as structural applications are on the way, and new suppliers are entering the field.

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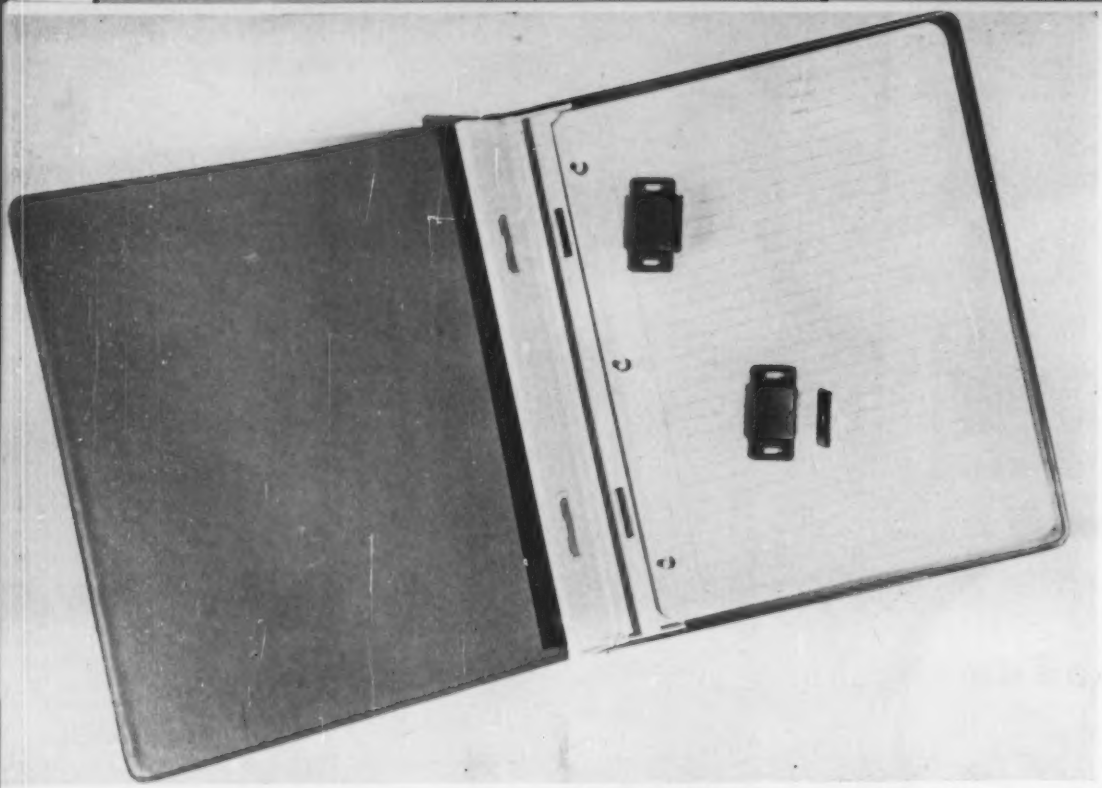
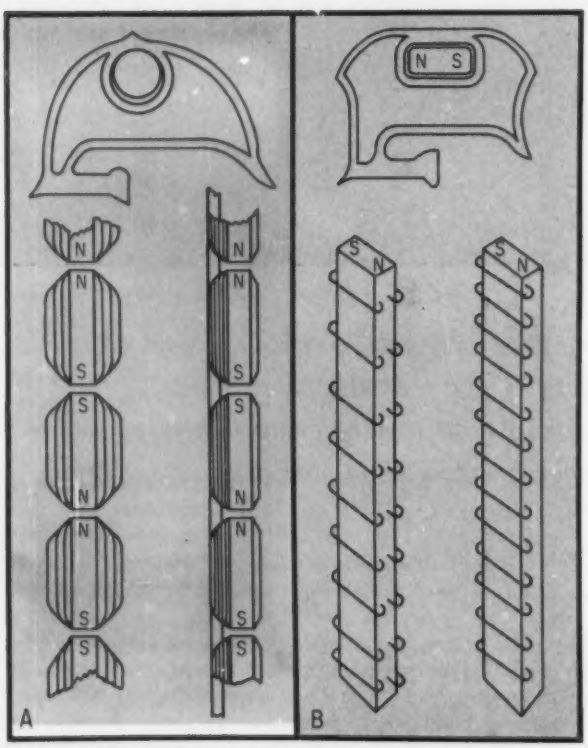
REPRINTED—Circle P77, inside back cover



MAGNETIC CLOSURES use flexible rubber strip rather than solid magnet for light weight, ease of fabrication. In notebook, magnets are built into paper holder. Similar construction is used in door closure. Note mating metal part in lower sample.



FLUX PATTERN of flexible magnet (B), as it might be used in a refrigerator door, is compared with that of individual magnets (A) in these diagrams from GE's Structures Design Engineering Section. In each pair, diagram at left shows flux pattern with door open; at right, closed.

Here are the advantages

Many factors contribute to the design value of flexible magnets. They offer light weight, chemical resistance and ease of fabrication that can't be matched by any of the hard materials; and, in some applications, they cost much less. They offer a range of properties, too, with some of the newer materials coming surprisingly close to the hard magnets in such properties as coercive force.

It is possible, for instance, to obtain materials with a maximum energy product (BH_{max}) of 2 x 10^6 gauss-oersteds—a very respectable figure as compared with solid ceramic magnets. Several types have a coercive force (H_c) in the range of 1150 to 1300 oersteds—again close to that of many ceramic magnets and nearly twice the figure given for Alnico V. Residual induction (B_r) may range from 1600 to 2100 gauss or more.

Another advantage of the flexible magnets is that they can be magnetized in a wide variety of patterns—on one or both sides, in crosswise stripes, or with north and south poles positioned along sides, edges and corners. However, it should be noted that the strongest pull is obtained with a one-sided magnetization on the broadest face.

Cost, too, can be a big plus for the bendable magnets. Prices vary a great deal, but it is possible to buy strip for as little as 10¢ a foot (this, in the ½ by ⅛-in. size), and fabrication is usually a simple matter.

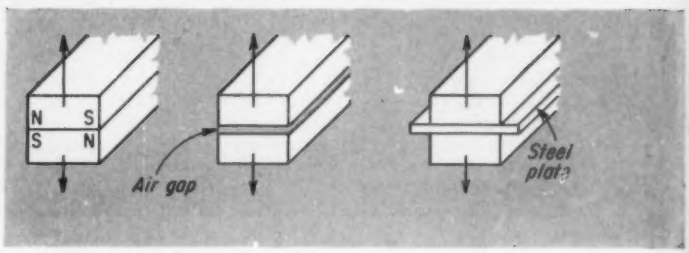
But watch these problems

Because flexible magnets are not generally as strong as solid magnets, and because their form and magnetic flux configuration are different, they cannot usually be

Plastic magnets—their strength and weight

Variation among flexible magnets, and variation in applications, make it difficult to specify exactly what is needed. Perhaps the best way is simply to ask for the "holding power" of the magnet under the specific conditions contemplated. Typical figures for one group of flexible plastic magnetic materials are given below:

Magnet size, in.	Weight, lb/ft	Pounds pull per linear inch 0.0-in. airgap	0.015-in. airgap
1/4 by 1/16	0.05	0.08	0.04
1 by 1/16	0.01	0.17	0.11
3/8 by 9/64	0.09	0.23	0.13
1 7/8 by 1/4	0.37	0.69	0.51



HOLDING POWER decreases rapidly with increasing airgap. With 0.055-in. gap between magnets in center drawing, holding power is cut in half. Insertion of steel strip of the same thickness however, does not affect total pull.

employed as direct substitutes for the solid materials. As a matter of fact, mere substitution would probably waste one of their biggest advantages—their ability to supply sealing and gasketing action as well as holding power.

In general, small flexible magnets should not even be considered where heavy weights or strong pulls are involved. Most flexible magnets in thin strips will hold little more than half a pound; a similar solid magnet can hold several times as much. On the other hand, when a fairly thick block or long strip of flexible material can be used, the pull can be quite considerable. Furthermore, holding power can be increased by providing a steel backup plate (as with the small rectangles in photo, p 65).

Design pointers

Because the flexible magnets have a higher coercive force than the Alnico types, but a considerably lower residual flux density, they have to be made in a different shape to achieve comparable performance. In general, as compared with metallic magnets, the flexible ones must be considerably larger in cross-section but shorter from pole to pole. The difference in shape as compared with ceramic magnets will not be as great, but is still likely to be significant in design.

Other problems in applying flexible magnets relate to the specific base material. For instance, the rubber-based types offer excellent flexibility, but may stiffen on aging, and may lack resistance to oil. The plastics, on the other hand, may show only minimum bendability in all but the thinnest sections, and may tend to stiffen in cold and soften under heat. In general, none is recommended for use under load at temperatures above 175 F. Even where load is not a factor, temperatures above 200 F are not recommended, since these materials also lose magnetic strength as the temperature rises (about 25% is lost by the time 175 F is reached).

Another problem with the flexible magnets is that of extension and compression-set. It might be expected that, under the force of closure, the rubber-based flexible magnets would tend to show a permanent compression-set. Actually, in some cases at least, the reverse is true: flexible magnets sometimes extend or pull out, preventing closure or interfering with proper mating of parts. One way to get around this problem is to incorporate the magnet in a gasket which will both hold the magnet and compensate for any changes in shape. A unit of this type is shown in the photo on page 65.

What's ahead?

Imaginative proponents of flexible magnetic materials see almost no limit to potential types and applications.

The Soviets are talking of magnets in paste form that can simply be molded to shape as if they were modeling clay (*PE*—Dec 26 '60, p 8). One possible application: midget motors and transformers, in which the plastic parts serve as insulators as well as magnets, helping to reduce over-all size (see p 8, this issue).

A US supplier is working on a sprayable iron powder composition that can be deposited on nonmagnetic materials to provide a surface that will attract a magnet, though it may not serve as a magnet itself.

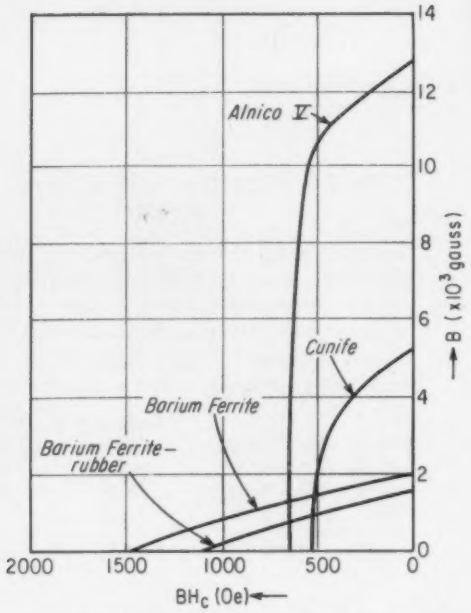
Flexible magnets are being offered with a variety of facings and backings—paper coverings and pressure-sensitive adhesives, for instance.

Improvements in materials now on the market, and in fabrication techniques, are opening many new industrial applications. For instance, the relatively low mechanical strength and tendency to flex-cracking of the

How the magnet types compare

(Typical properties for metallic, ceramic, and flexible magnets now available commercially. Oriented barium ferrite flexible magnets, being readied for introduction, will come closer to the oriented ceramics than nonoriented material charted. They will, for instance, have a maximum energy product in the 2×10^6 range.)

	Alnico V	Barium Ferrite nonoriented	Barium Ferrite oriented	Flexible (nonoriented)
Residual flux density, B_r	12,000 gauss	2100 gauss	3750 gauss	2100 gauss
Coercive force, H_c	650 oersteds	1650 oersteds	2000 oersteds	1300 oersteds
Maximum energy product, BH_{max}	4.5×10^6 g-o	1×10^6 g-o	3.2×10^6	1×10^6 g-o
Density, lb/cu in.	0.264	0.173	0.180	0.123
Specific gravity	7.4	4.8	5.0	3.7
Resistivity, ohm-cm	55×10^{-6}	$>10^6$	$>10^6$	3.54×10^{10}
Tensile strength, psi	5,500	.....	.....	650
Elongation, %	~0	~0	~0	3.25



DEMAGNETIZATION CURVES of flexible and hard magnets are compared in this chart from a Japanese report. Flexible magnetic material here is nonoriented barium ferrite dispersed in isotropic rubber. With anisotropic rubber and oriented barium ferrite, curve would more closely approximate that of barium ferrite itself.

flexible magnets has limited their use in such applications as conveyor belting. Now, however, techniques are being developed for bonding a magnetic cover to a conventional carcass which may help overcome this limitation. Bonding flexible magnetic strips to very thin, flexible steel backings may open a good many design fields, providing an effective compromise between strength and flexibility, and making it possible to take advantage of the cushioning effect of the elastomer.

Other ideas—strictly on the consumer side—might include belts that would hold at any point at which the ends overlapped; a rubber-stamp-pad holder that will simply pick up any one of a series of rubber stamps—eliminating the need for extra holders; small magnetic strips that can be dropped into a package of cigarets or wrapped around a pencil to attach either of these to a car dashboard; and fishhook and fastener boxes that would hold their contents no matter how they were tipped.

The availability of flexible magnetic cord may open a variety of applications—in the electrical as well as the novelty field. Cord of $\frac{1}{32}$ in. dia costs only 3 to 6¢ a foot, and weighs barely 0.01 lb/ft.

Electrical applications for flexible magnets are only beginning to be explored. One company, for instance, is working on flexible circuit components for simple electrical devices. Another (*PE*—Sep 19 '60, p 8) has suggested the possibility of turning vehicle wheels into electrical generators by incorporating magnetic strips in the tires. A third is testing the materials for possible application in computer "memories."

One of the most promising immediate applications for flexible magnets is in individual closures—simple locks and latches— and relief "valves" that will "give" under predetermined pressure, and then close themselves automatically when the pressure drops. Here, light weight and ease of fabrication are primary advantages, rather than the flexibility itself.

Flexible magnets are being used, in conjunction with plastic gaskets, as full-door liner-closures for refrigerators. However, use of the magnet as both a gasket and a closure must still be labeled "experimental." Designers have run into problems of discontinuity at the corners and dispersion of the attractive force so there is no single, strong pull at a central point, and these are still holding back several projected applications. Too, the question of particle pickup and its effects on large-size applications is still being evaluated.

For those who want to experiment with flexible magnets, one supplier offers a strip-coil-and-cord kit with more than a dozen samples for about $4.95. Others are ready to fill sample orders for a foot or two of any specific material—at higher than quantity prices of course, but still providing a respectable amount for a few dollars.

Among the companies now producing materials of this type, or supplying fabricated shapes, are Applied Magnetics Corp, Crest Co, Denman Rubber, General Tire & Rubber, B F Goodrich, and Swift Levick & Son of England.

For REPRINT of above article, just check P77 on one of the Reader Service cards found in this issue.

EDITOR'S NOTE: For more on magnets and their application in product design, see:

Applications for Permanent Magnets, March '55, p 160—A design roundup of 11 ways to use magnets in drives, switches, and other mechanisms.

What You Should Know About New Magnets, Dec 2 '57, p 34—Reviews the characteristics of hard magnets.

Hermetic Magnetic Couplings, Apr 28 '58, p 98—Applying permanent magnets to the problem of transmitting torque through a steel wall and preventing leakage of fluid.

MULTIMETAL PARTS STAMPED FROM CLAD METAL STRIP

A preassembled sandwich can be an economical way to get the metals you want—in the positions you want them—for high bond strength and close dimension control.

BRIAN COAD, *development engineer*
Texas Instruments Inc, Metals and Controls Div, Attleboro, Mass

There are three main reasons for specifying clad metals in precision electromechanical devices:

1. To conserve valuable metal where its properties are needed only at the surface or in an isolated area of a part.

2. To provide a combination of the properties of the component metals or alloys.

3. To provide new properties unobtainable in a single metal or alloy.

A fourth useful function is emerging for clad metals, even though specifications of most composites fall into one or more of the first three categories. This fourth function is:

4. To provide a preassembled composite metal strip from which ready-to-use components can be blanked or chopped.

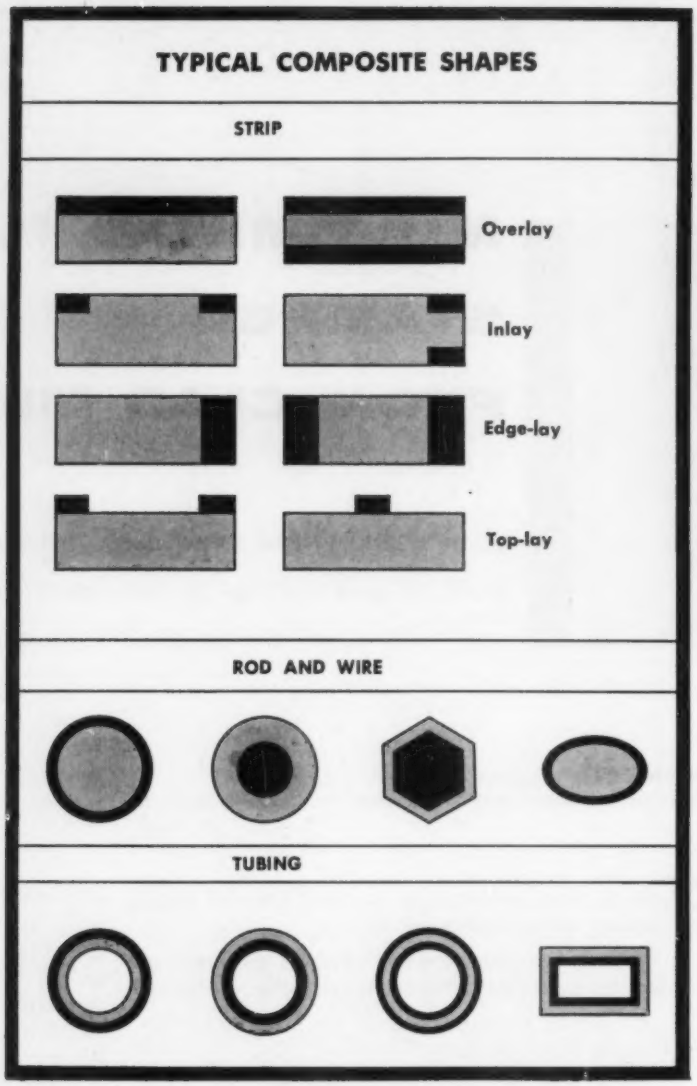
The tiny parts shown on p 70 typify such components. Parts like these can be stamped from metals clad in any of four basic forms—overlay, inlay, edge-lay, and top-lay—as sketched in the section diagrams. Non-flat parts can be designed from composite rod, wire, or tubing.

To produce these various forms of clad metal, three basic processes are employed:

1. Cold bonding is a rolling process wherein strips of two or more ductile metals are stacked, passed through rolls and reduced as much as 60% in thickness in one pass. Roll pressure forces the metals into one another at the interface. Only ductile metals can be roll-bonded, and only in overlay or simple inlay form. When an appreciable hardness difference exists, thin layers of the soft metal can be bonded on thick bases of hard metals, but not vice versa. Maximum size of composites is about 0.100 in. thick x 12 in. wide, so far.

2. Hot bonding is similar to cold bonding but has to be a batch process because the strips or billets require preheating. Reductions of as little as 10% in thickness will then give a sound solid-phase bond. As in cold bonding, all ductile metals and alloys are suitable. However, ductility need not be as good because of the lower reduction, and as-bonded thicknesses may be as high as 0.250 in. Since the components are rolled hot, special grooved rolls will produce profiled surfaces.

3. Brazing or soldering extends the possible range of thicknesses and thickness ratios by assembling strips, sheets or billets by means of a sheet of solder or brazing alloy between them—rather than by rolling. The sheet melts and forms a bond when the sandwich is heated to the proper temperature. This is usually a batch process, but can be made continuous. It is especially useful for short runs of complex cross-sections of top-lay form. Final parts are limited in their operational temperature by the melting



temperature of the interface alloy that forms during the bonding process. This limiting temperature must be determined before the part goes into mass production.

Selection of materials

So long as ductility limitations are followed, just about any combination of metal or alloys can be bonded in nearly any ratio of thicknesses. Practicality is the only limit on the number of component metals that can be joined into one composite. A good example is copper-cored Aliron, a 5-layer composite material having good thermal and electrical conductivity and sufficient strength given by steel layers sandwiching a copper layer, plus "black-body" properties given by intermetallic compounds between steel and the aluminum outer facings. Some common 2-metal combinations used in preassembled clad-metal parts are listed in the table. These do not represent all of the possible combinations or application areas.

Cladding a rigid base member with a precisely controlled layer of solder or brazing alloy is a method of simplifying design, production and reliability of precision devices. Solder-clad composites can be made in all four basic forms. Inlaid strips of solder have proven invaluable where a very limited amount of precisely located solder can be tolerated—in transistors, for example. Solder preclad in place means less pieces to handle at assembly, and ensures full prewetting of the base member. Exotic and expensive solder alloys can be specified since the amounts used can be carefully controlled in the bonding operation. The only limitation in solder cladding is that ductile alloys must be used.

The major application of edge-lay and top-lay combina-

COMMON COMBINATIONS OF COMMERCIAL CLAD METALS

(Forms available are: O—overlay; T—top-lay; I—inlay; W—wire; Tu—tubes)

BASE METAL	CLADDING	FORM	APPLICATION
Copper	Silver	O, T, I, W	Electrical contacts
Nickel	Tin	O, I	Soldering of transistors
Molybdenum	Gold	O	Soldering of transistors
Molybdenum	Aluminum	O	Soldering of transistors
Phosphor Bronze	Silver	O, T, I	Electrical contacts
Thermostat Bimetal	Silver	I	Electrical contacts
Nickel	Silver Solder	T	Brazing carbide tools
1065 Steel	Copper	T	Springs having good electrical conductivity
Copper	Glass-sealing alloy	W	Glass-metal sealing with good electrical conductivity
Copper	Aluminum	T, Tu	Connecting Al parts to Cu parts

tions is in preassembled electrical contacts in order to preserve expensive contact materials like silver or silver alloys. Base metal here is generally copper or one of the bronzes.

Design considerations

Once the base metal and cladding have been tentatively selected, and you are satisfied that one of the three processes will join them, the decision to design a part from a composite metal hinges on three questions:

- Are the pieces to be joined geometrically compatible?
- Can the part be blanked or formed from one of the basic clad-metal forms?
- Must the two components of the part be kept separate for reasons of assembly, operation or maintenance?

If the first two questions are answered "yes" and the third one "no," then preassembled clad components may be the most economical answer.

When the decision is for clad metal, there are several final design points to be checked:

Severe bends directly adjacent to inlay, edge-lay, and top-lay cladding should be avoided. This will minimize the possibility of the cladding separating at sharp bends. Initial temper should be established by test to allow adequate ductility when forming is severe.

When annealing is possible, formability will be as good as that of the least formable component metal. Composites can be annealed only if there is no high-temperature incompatibility between base and cladding. Such problems would be: formation of brittle intermetallic compounds, or the melting of one component (a solder, for example) before the annealing temperature is reached. When a composite is annealed, any normal forming process can be used.

Trimetals may be cheaper when the cladding is an expensive metal needed in a raised area—as in many electrical contacts. The third metal can be used to build the projection on the base metal; an alternative method uses offset bends to get the desired projection.

Scrap should be minimized by designing the part so that it can be nested efficiently on the stamping strip, or by designing the strip so that a simple shearing operation will form the part. For electrical contacts having a single contact area, it is often best to design so that a double-width strip can be used—with pieces blanked from each edge. This step simplifies coiling and feeding the strip.

EDITOR'S NOTE: Other recent articles on methods of joining dissimilar metals in a single assembly include:

Welding or Brazing Dissimilar Metals, Dec. 19 '60, p 46—Discusses three basic ways to make high-pressure, no-leak joints between widely different alloy systems.

Electron Beam Welds in Vacuum, July 18 '60, p 70—Shows how dissimilar metals can be joined through high-energy concentration of electron beam; gives design criteria.

High Frequency—What It Means to Welding Design, Jan 4 '60, p 42—Operate an electric welder at the higher frequencies and you get stronger welds in a wider variety of materials. Technique can be extended to dissimilar metals too.

What the Tests Show About Soldered Aluminum Joints, Dec 7 '59, p 84—There are dozens of aluminum solders to choose from, and some are good for joining aluminum to other metals like copper and its alloys.

Predicting Gap Change in Brazing Dissimilar Metal Joints, Mid-Sep '57, p 365—Nomographic calculations allow predicting what will happen to initial clearance when parts are heated to brazing temperature.

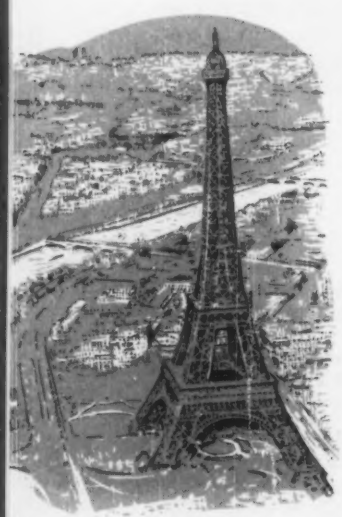
How Gaskets Behave When Flange Metals Don't Match and Temperatures Fluctuate, May 25 '59, p 40—Sparked by more aluminum in auto engines, gasket design techniques are being overhauled to fight high-temperature loosening.

Magnetic Force Welding for Vinyl-clad Steel, Sep 15 '58, p 82—Article deals mainly with plastic-coated steel, but explains basics of a joining process developed specifically for joining dissimilar metals in electrical contacts.

Ultrasonic Soldering, Brazing and Welding, Mid-Oct '57, p G-14—Ultrasonic welding facilitates the joining of similar or dissimilar metals that are normally difficult or impossible to join by conventional methods.

FOREIGN ENGINEERS DON'T ARGUE PATENT RIGHTS

One reason for less controversy abroad—in most countries, inventions are undisputed property of the company. Here's a roundup from McGraw-Hill news bureaus, contrasting your situation with that in six other nations.



Signing away your patent rights to get a job has become a controversial point in this country. But engineers abroad, for the most part, don't even question the practice. They have very little choice. In most cases the practice is required by their country's laws. And where there's no uniform code, the abdication of rights is usually accepted as a fair condition of employment—a small price to pay for the job security offered by a large corporation.

The different situation in the US is shown by considerable argument over the fairness of patent agreements (and, indeed, their legality). Outspoken opponents have criticized the practice (*PE—July 28 '58, p 26*) because they see it stifling the engineer's creativeness and exploiting his talents. Corporate spokesmen, on the other hand, argue that the engineer's creative output rightfully belongs to the employer—it's his stock in trade. When PRODUCT ENGINEERING asked a patent attorney to appraise standard agreements prepared by 30 large corporations (*PE—June 20 '60, p 62*) his verdict was: the contracts are reasonable and fair, except when they require disclosure and assignment of invention for a period *after termination of employment.*

Now how does this compare with the situation abroad? To find out, we asked correspondents in six foreign countries to survey patent attorneys and engineering firms. Here are the results.

France

Patent agreements like the ones American engineers sign are rare in France (a check of 10 metalworking plants failed to turn up a single one). Instead, there are work contracts. The terms of the contracts are established by collective bargaining and usually stipulate that an employe's inventions are the property of the employer. For an important invention, however, the company often awards a bonus or promotion to the inventor.

In France, nearly everyone signs a work contract—janitors sign them, production-line workers sign them, engineers sign them, company presidents sign them. Those firms that do not cover themselves with a specific clause in the contract are covered anyway. The French code states, albeit in a general way, that benefits of any activity carried out in the course of an employe's work are the property of the employer.

To avoid possible misinterpretation, companies have chosen to add a specific agreement to the work contract. What, for example, is an activity "carried out in the course of an employe's work"? Court rulings help clarify the situation but are not always adequate. In one case, the court played it down the middle, decided that engineer and company were 50-50 owners of the patent because, although the invention had nothing to do with the engineer's work, part of the development was done in company labs.

The standard French arrangement works mostly because engineers usually stick with one company—and companies in allied fields are closely knit. One top executive for a large instrument manufacturer (where only one engineer has left in the last six years) puts it this way: "It's unthinkable that one of our engineers would try to exploit one of his discoveries made in the course of his job. But if he did, I could make about 20 phone calls and he'd never find another job in France."

Perhaps a better reason for lack of patent squabbles is the one that applies the world over: Inventions these days are usually a team effort. No one engineer can rightfully take the credit or claim the invention.

Italy

As in France, most Italian engineers sign a work contract with a clause that serves as a patent agreement. When there is no such contract, however, the firm usually asks the engineer to sign an agreement that gives the company an option to buy rights to an employe's invention. The Italian civil code automatically protects both parties to some extent, but it is not followed very closely in practice.

The option system works this way. When an engineer invents a device, he takes out a patent in his own name. The firm then has the option to buy the patent outright, use the patent under license, or turn it back to the engineer so that he may exploit it. The purchase or licensing fees are established by individual agreement between the engineer and his company and are usually smaller than that which would be paid to an outsider. If they cannot agree on the amount to be paid, the matter is usually settled by a board of arbitrators: a representative of the firm, a representative of the engineer and a neutral third.

Italian law requires that an engineer be paid extra for inventions but this is not restated in the work contract and a bonus is rarely paid. The law also states that the firm has claim to inventions made up to a year after the engineer leaves the firm. But this applies only to inventions within the scope of the ex-employer's sphere of activities.

In Italy, company secrets are more important than patents. Patents are easy to get; patent officers are not qualified to decide whether an invention is really new. Consequently, patents are difficult to defend. Only the most important and truly original inventions are patented. The rest remain the secret know-how of the firm and such secrets are protected by a law which obliges employes not to disclose such proprietary information. In practice, the secrets are passed on from company to company with the changing staff, a situation that is accepted by the company as inevitable.

Switzerland

In Switzerland, the law's the thing, whether there is a specific agreement between employer and employe or not. But here, it is actually to the engineer's advantage to sign an agreement; under this arrangement, the law protects his right to be paid for any of his inventions. Otherwise, he has no legal recourse to collect payment.

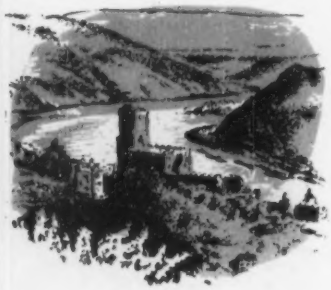
Although it is really unnecessary, larger firms generally include a patent-agreement paragraph in their contracts with employes. There is also usually some mention of compensation but it generally avoids stating a specified amount, leaving this for individual negotiation. A few of the more research-oriented companies encourage invention by compensating the inventor even in cases where they would not be obliged to do so by law.

A spokesman for E Blum & Co of Zurich, one of Switzerland's leading firms of patent attorneys, claims that engineers generally regard current patent practices as satisfactory. Engineers find it natural that their inventions should become the property of their employers since their creative contributions are what they are engaged and paid for. And because the engineer's inventions legally fall to the employer, he is in a position to bargain for conditions of employment he might not otherwise obtain so easily.

England

The English patent-agreement system is much like ours but with perhaps more reliance on the integrity of the individual. Although the percentage of companies requiring a signed agreement is generally assumed to be small, a recent survey indicates that for R & D staffs, the actual number is close to 65%.

Of existing agreements, most follow the American pattern as regards disclosure of inventions, assignment of rights, and company secrecy. But, in addition, they typically include a clause stating that inventions rejected



by the company become the property of the engineer. They further state that in such cases, expense of obtaining the patent is not recoverable from the engineer.

There are still a few agreements that, in the opinion of some engineers, demand too much of the employe. Some, for example, require that patents be assigned to an ex-employer for a period after leaving the company. Others extend the agreement to cover any invention made by an employe.

But for the most part, they are fair documents, accepted by engineers in Britain as a reasonable condition of employment. PRODUCT ENGINEERING could find no evidence of rancor among engineers. The usual attitude is that a written agreement only confirms what any honest professional would assume as his obligations.

Germany

Because of a recent (1957) change in the German patent law, patent agreements are no longer necessary. In fact, after a careful study of the new law, most companies gave written notice to their engineering staff that previous agreements would be considered null and void. Germans on both sides of the fence regard the new law as reasonably fair to both employer and employe.

The new law calls for an immediate disclosure and eventual assignment of inventions to the company. The rule is inflexible, applies to any invention where company time, materials, or assistance are involved. But the employer has to decide within four months whether to exploit the invention or hand it back to the inventor. Inventions made outside working hours, and in no way connected with company business, remain the property of the engineer and he can apply for the patent in his own name.

The law also outlines the procedures for determining the amount of compensation to be paid. Payment decreases with increasing status: a chief engineer gets less than staff engineer or draftsman. Fees are usually agreed upon by a joint committee consisting of the company patent attorney, plant technical director and the inventor. This group attempts to assess the value of the invention to the company. If the inventor is dissatisfied with the decision, he has recourse to several levels of appeals machinery, but for the most part, patent squabbles rarely get beyond the first level.

After termination of employment, the engineer is not bound by an extended agreement and is not required to disclose or assign inventions to his former employer. However, if an engineer discloses an invention to the company during his term of employment and if the company turns it down, the company has some claim even if the invention has already been assigned to a third party. The company can buy it back by simply paying an agreed-upon fee to both the engineer and the third party. Of course, this applies only to patents relating to company business.

Japan

There is no possibility of an employe's ownership of inventions in Japan; Article 35 of the Japanese patent law requires all patents to be registered in the name of the engineer's company. The inventor is sometimes paid a bonus for his creative effort but this is usually no more than $10 or $15 a month for an indefinite period of time. (This, however, is not as small as it seems. A top-ranking university professor in Japan receives a salary of about $100 per month and recent engineering graduates generally receive no more than $50 to $60 a month.)

Engineers submit to this kind of treatment willingly. Good jobs are not easy to get in Japan and an unfavorable patent arrangement is a small price to pay for the opportunity to work for a large company, with its offers of security and fringe benefits (insurance, hospitalization, etc.). The engineer assumes (and his employer assumes) he will work for the company for the rest of his life—or at least until the retirement age, which is early and often enforced to make way for the endless number of workers coming up.

In the case of government employes (most Japanese research is in government laboratories), the government claims the patent. It may turn it over to private industry, in which case royalties go to the laboratories with perhaps a 3 or 4% rake-off going to the inventor.

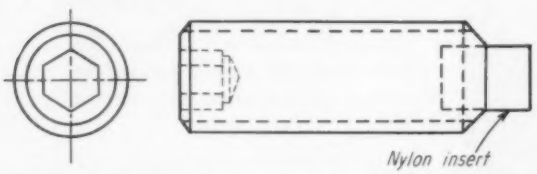
One drawback to an improved patent agreement is the Japanese feeling for equality. As one scientist-bureaucrat put it, "We Japanese believe it would be unfair to pay one man a much higher income than another, even though he may have made an important scientific discovery. This is perhaps our greatest barrier to increased productivity." ■

don't overlook NEAR-STANDARD FASTENERS

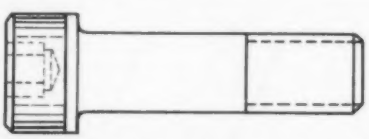
These specials, varying only slightly from standard, can save assembly time, money.

C A HANSEN, *manager, Special Industrial Fasteners Div*
Standard Pressed Steel Co, Jenkintown, Penna

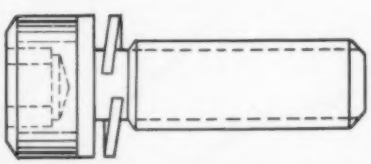
When specifications for fasteners vary only slightly from generally accepted standards, you may likely save money by making a systematic inquiry for unlisted "near-standards." How available a certain variation may be depends on how often the fastener-makers are called on to provide it. A periodic demand for certain types of modifications allows you to obtain the near-standard specials for little more than the cost of the standard. The kinds of near-standards vary with each fastener-maker, but the following types are typical:



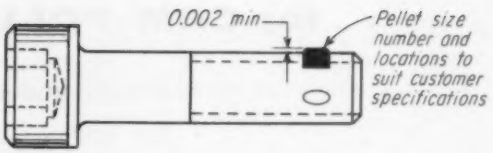
GRIP-TIGHT SETSCREW is tipped with a half-dog nylon insert; can be torqued down tight against fragile, brittle, or soft shafts made of glass, plastic, fiber or the like; or it can bear against threaded portions of the shaft without marring the thread. Repeated removals and reinsertions can be made without damaging the nylon point.



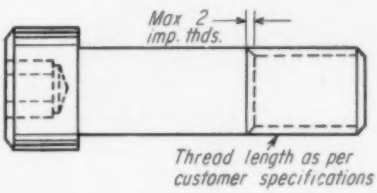
TIGHT-QUARTERS CAPSCREW has a head height just one-half that of the standard capscrew. This makes it ideal for counterbored holes in thin sections, or in assemblies where head space may be limited. It is used to replace hex, slotted or fillister-head screws where higher strength and torquing capabilities are required.



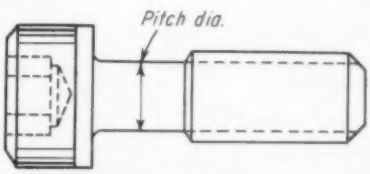
CAPTIVE LOCKING WASHER becomes integral part of this screw assembly, by making it captive on a necked-in area below the screw head. This prevents misplacement or loss of the lock washer when screws are removed for any purpose. At the same time, it speeds assembly and eliminates danger that the screw will be reassembled without the lock washer.



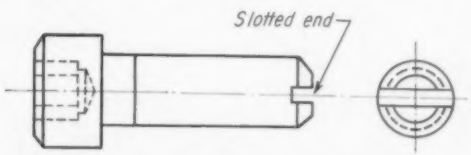
VARIABLE LOCKING-TORQUE FASTENERS are designed to give predetermined torque. Standard nylon-insert self-locking screws may give too much or too little locking action, particularly when screws are used with soft materials where the nylon pellet might damage mating threads. Therefore vary the number or size of nylon pellets to suit the need.



SPECIAL THREAD-LENGTH SCREW is made to suit any desirable stripping strength. It can be threaded just a few turns at the tip to replace stripper bolts in some applications. Where feasible, this "special" could be obtained at less cost than standard stripper bolts, and would afford higher strength since it eliminates the weakness inherent in the stripper-bolt neck.



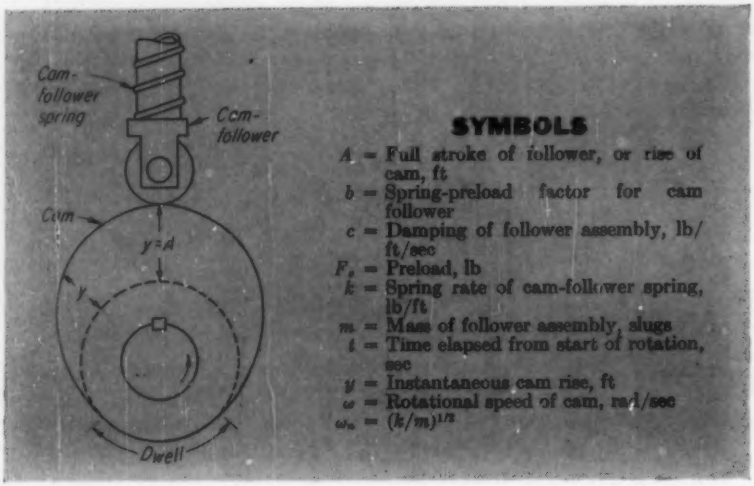
CAPTIVE SOCKET SCREW has a reduced shank and relatively short threaded section; allows screwing the fastener through a threaded panel, and making it slide freely after it has been turned past the threaded area. The screw is used in many electrical panel assemblies where it performs its assembly function without falling completely out of the panel. Also useful in machinery for securing cover or inspection plates or for positioning behind a frame or panel.



SLOTTED-END CAPSCREW permits turning from either end. It can be fully tightened with access only to the nut end of the assembly. A screwdriver in the slot keeps the screw from turning, while the nut is being wrenched. Sometimes an awkward location makes end slot helpful as means for partly tightening or adjusting to minimize final wrenching.

PROPER PRELOAD
for CAM-FOLLOWER SPRINGS

Charts and equations quickly determine the right preload for harmonic and parabolic cams.



SYMBOLS

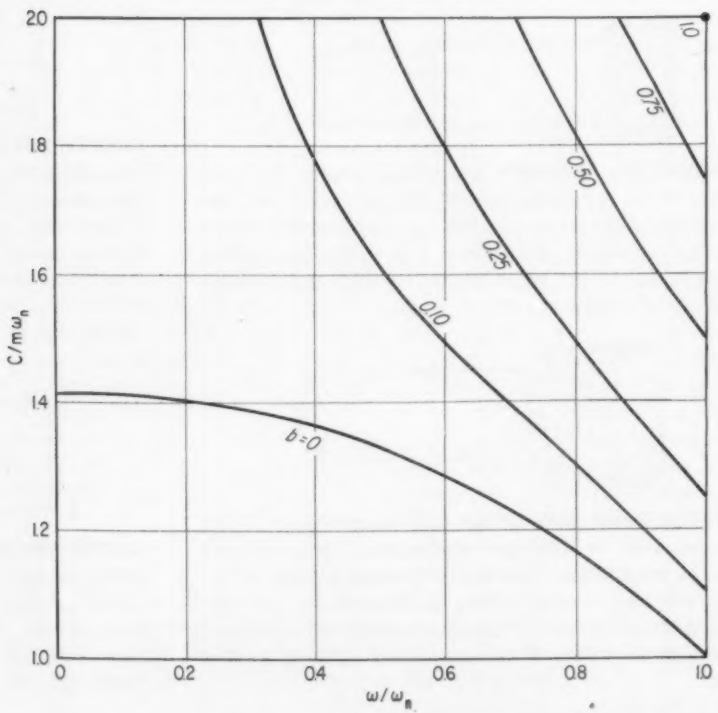
A = Full stroke of follower, or rise of cam, ft
b = Spring-preload factor for cam follower
c = Damping of follower assembly, lb/ft/sec
F_o = Preload, lb
k = Spring rate of cam-follower spring, lb/ft
m = Mass of follower assembly, slugs
t = Time elapsed from start of rotation, sec
y = Instantaneous cam rise, ft
ω = Rotational speed of cam, rad/sec
$\omega_n = (k/m)^{1/2}$

It's the job of the cam-follower spring to hold this follower against the cam throughout each cycle. To do this effectively, its preload (the initial downward force during the dwell part of the cycle) must be carefully selected. If preload is too little, the follower will jump; if preload is too great, rotating the cam will absorb more power than necessary.

Curves and equations in this article quickly find the proper preload for two kinds of cams, harmonic and parabolic.

F H FOWLER JR, *computer engineer*
Westinghouse Electric Corp

HARMONIC CAM



Equations

The harmonic cam, whose formula is $y = 0.5A$ (1-cos ω t), gives follower acceleration proportional to excursion. The parabolic cam gives an acceleration constant in magnitude, but with alternating sign. During rise, acceleration is positive. During fall, acceleration is negative. Its formulas are:

$y = 0.5A\ [4\ (\omega t/\pi)^2]$, when $0 \leqq \omega t \leqq \pi/2$

$= 0.5A\ [2 - 4\ (\omega t/\pi - 1)^2]$, when $\pi/2 \leqq \omega t \leqq 3\pi/2$

$= 0.5A\ [4\ (\omega t/\pi - 2)^2]$, when $3\pi/2 \leqq \omega t \leqq 2\pi$

In any case:

Preload $F_o = 0.5Akb$, where b is preload factor, determined from the curves.

Example: A harmonic and parabolic cam rotate at 1200 rpm. For the cam-follower assembly, mass $m = 1.554 \times 10^{-3}$ slugs, and spring rate $k = 217$ lb/ft. Damping c for the cam-follower assembly is 5.83 lb/ft/sec. Cam rise is 0.50 in. What is proper cam-follower-spring preload for each cam?

Solution:

Find the parameters needed for the curves.

$\omega_n = (k/m)^{1/2} = (217/1.554 \times 10^{-3})^{1/2} = 209.5$

$c/m\omega_n = 5.83/1.554 \times 10^{-3} \times 209.5 = 1.79$

$\omega/\omega_n = 1200 \times 2\pi/60 \times 209.5 = 0.60$

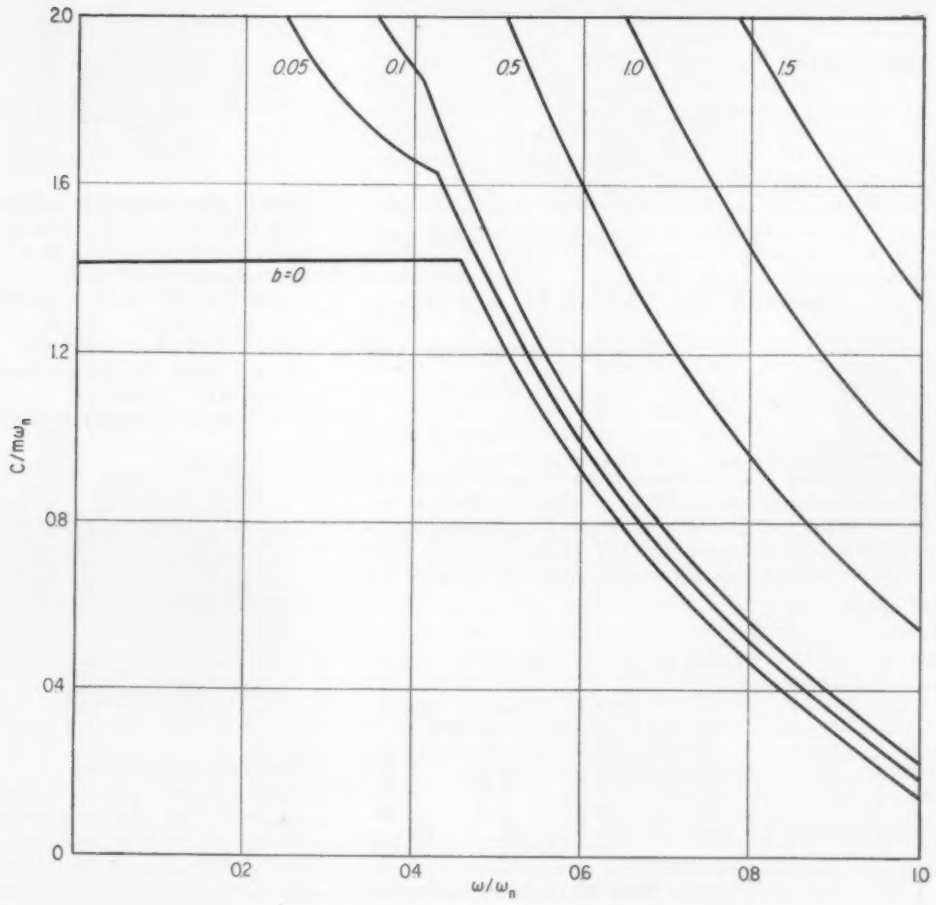
From curve for harmonic cam find preload factor $b = 0.25$.

Preload $F_o = 0.5Akb = (0.5 \times 0.50 \times 217 \times 0.25)/12 = 1.13$ lb

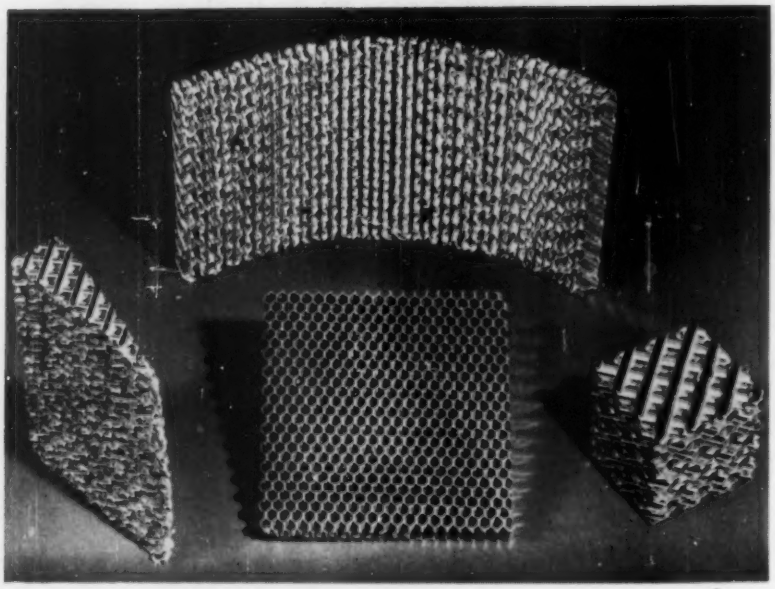
From curve for parabolic cam find $b = 0.65$.

Preload $F_o = 0.5Akb = (0.50 \times 217 \times 0.65)/12 = 2.94$ lb

PARABOLIC CAM



SIGNIFICANT COMPONENTS MATERIALS, PROCESSES



Aluminum sandwich panels . . .

reportedly are stronger in all dimensions than hexagonal honeycomb-core panels. Cross-laminated layers of corrugated aluminum foil resist 25 times more crushing force —applied perpendicular to cell axis—than an equal weight of regular honeycomb. Since each foil layer's corrugations form 90° angles with neighboring ones, alternate-layer channels run in same direction, providing strength and rigidity in three planes. Can be shaped by roll-forming and crushing and can be bonded with all types of adhesives without perforating cell walls. Available in slices, blocks, tapers, contoured shapes and curvatures at $10 to $25 per cu ft, depending upon specified core density, foil thickness and corrugation size. Standard slices are 96 to 98 x 12 to 12¼ in., in thicknesses from ¼ to 6 in. Delivery in 10 days. **General Grid Corp, 713 Stokes Rd, Army Chemical Center, Md.**

Circle 300 on Reader Service Card

High-impact gum plastics . . .

for molding and extrusion applications, have room-temperature impact strengths from 0.4 to 3.6 ft-lb/in., and tensile strengths from 11,800 to 4500 psi. Available in two series: Lustran A (acrylonitrile-styrene copolymers) and Lustran I (acrylonitrile-butadiene-styrene terpolymers). Latter is made in one extrusion and two molding forms. From stock at 37 to 51¢ per lb in carload quantities. **Plastics Div, Monsanto Chemical Co, Springfield, Mass.**

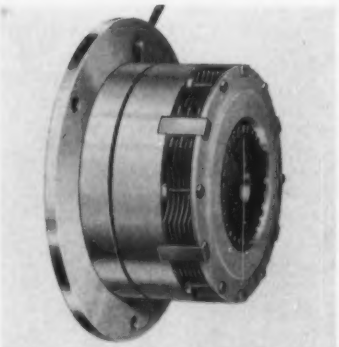
Property	Lustran A	Lustran I		
		Type 1	Type 2 (extrusion grade)	Type 3
Impact strength, ft-lb/in.	0.4	3.0	3.6	1.8
Tensile strength, psi × 1000	11.8	5.8	4.5	6.5
Yield strength, psi × 1000	11.8	6.5	5.3	8.0
Yield elongation, %	3.0	3.0	2.5	3.0
Heat-distort. temp, °F at 264 psi	196	175	185	177

Circle 301 on Reader Service Card

Zinc die-casting alloy . . .

casts at 760 F—30 deg lower than other alloys in same series. Said to produce larger, more complex castings with thinner wall sections. Mechanical characteristics approximate others in series. Has tensile strength of 41,000 psi; impact strength of 40 ft-lb determined on ¼ x ¼-in. bar, Charpy scale; Brinell hardness of 76; and elongation of 14% of 2-in. length. From stock at approx 50½¢ per lb. **New Jersey Zinc Co, 160 Front St, New York 38.**

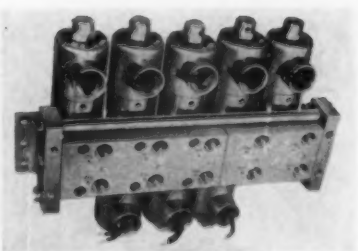
Circle 302 on Reader Service Card



Small-size magnetic brakes . . .

have 35 to 32,500 in.-lb torque capacities, made possible by isolating friction plates from magnetic fields. Incorporate power-applied principle similar to multiple-disk type electromagnetic clutches. Twelve standard sizes range in dia from 2.25 to 11.5 in. **Airflex Div, Fawick Corp, 9919 Clinton Rd, Cleveland 11.**

Circle 303 on Reader Service Card

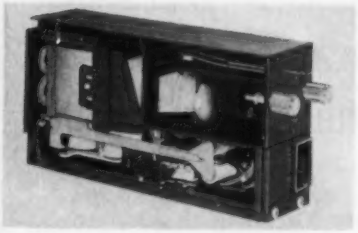


Multiple subplates . . .

permit a number of valves to function as one unit. Two- and three-place mounts are used to build up multivalve stations in unlimited series. Additional blocks can be added, using screwdriver and allen

wrench. Only one inlet or one exhaust connection is needed to feed entire block. Solenoids usable in assemblies have $\frac{7}{16}$-in.-dia flow passages. **Versa Products Co Inc, 150 Coolidge Ave, Englewood, NJ.**

Circle 304 on Reader Service Card



Alphanumeric readout . . .

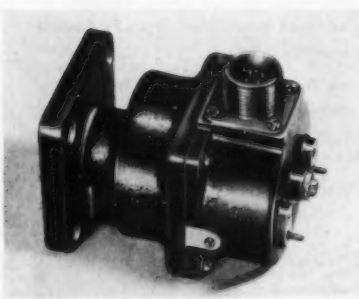
is self-decoding. Accepts any binary coded decimal up to six bits, does its own translating and displays proper $1\frac{3}{8}$-in.-high character. Operates with as little as 10-milliw-per-bit signal power, and displays up to 20 characters per sec. Continues to display last character entered after signal-pulse and set-pulse power have been removed. Measures $3\frac{1}{4}$ x $1\frac{3}{4}$ x $6\frac{3}{4}$ in. and weighs approx 2 lb. Standard 12-character unit is priced at $50. Delivery in 60 days. **Industrial Electronic Engineers Inc, 5528 Vineland Ave, North Hollywood, Calif.**

Circle 305 on Reader Service Card

10-hp hydraulic transmission

provides infintely variable speeds from 0 to 1600 rpm for high-torque, heavy-duty uses. Drives at 1800 rpm or less with 2- to 10-hp motor or 20-hp gas engine. Measures 22 x 13 x 16 in. and weighs 100 lb. Input shaft dia is $1\frac{1}{4}$ in.; output shaft, $1\frac{3}{8}$ in. Both are 4 in. long. From stock at $299. **Roberts Electric Co, 849 W Grand Ave, Chicago 22.**

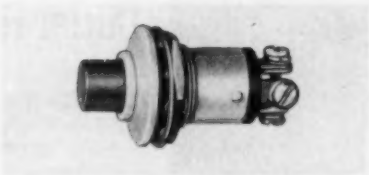
Circle 306 on Reader Service Card



Speed-sensitive switch . . .

operates at up to 8000 rpm, not exceeding ±1.5% error, over a temperature range of −65 to 400 F and vibration range of ±10 g to 2000 cps. Can be furnished with three normally open or closed switches for three separate settings. Senses shaft speed by means of flyweights mounted on miniature ball bearings. As speed increases, flyweights are thrown into larger dia orbits which raise spring-loaded cylindrical cam used to actuate miniature precision switch. Measures 2.437 x 2.437 x 3.65 in. and weighs 1 lb. Rated at 2.5 amp inductive at 28 v dc. **Cosmodyne Corp, 12833 Simms Ave, Hawthorne, Calif.**

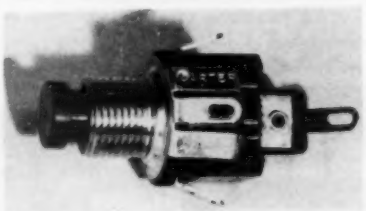
Circle 307 on Reader Service Card



Heavy-duty terminal switch . . .

is rated at 10 amp at 28 v dc resistive; 5 amp at 28 v dc inductive; 3 amp at 28 v dc lamp; or 15 amp (0.75 power factor) at 120 v ac. Said to last for 25,000 operations at rated load. Requires 4-lb operating pressure and $\frac{3}{8}$-in. mounting hole. **Control Switch Div, Controls Company of America, Folcroft, Penna.**

Circle 308 on Reader Service Card



Low-power pushbutton switch . . .

is suitable for 50-w or less applications. Rated for $\frac{1}{4}$ amp at 115 v ac straight resistive; 2 amp at 30 v dc resistive. Has molded construction in open, closed and DT configurations. Black or red pushbuttons are standard. **Carter Parts Co, Dept 23, 3401 Madison St, Skokie, Ill.**

Circle 309 on Reader Service Card

Subminiature switch . . .

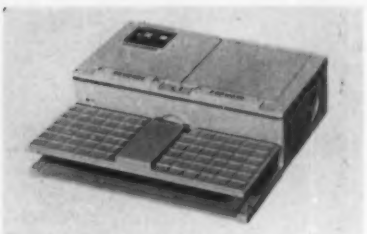
maintains differential travel within 0.001-in. Operating force is max $3\frac{1}{2}$ oz; release force, 1 oz max; overtravel, 0.003-in. min; and break travel, 0.008-in. min. Rated at 30 v with 3-amp inductive, 5-amp resistive and 24-amp max inrush. UL listing is 5 amp at 125 or 250 v ac. Priced at $1.90. **Micro Switch Div, Minneapolis-Honeywell Regulator Co, Freeport, Ill.**

Circle 310 on Reader Service Card

High-strength steels . . .

have min yield points of 50,000 and 45,000 psi. Available as plates and hot-rolled sheets and strip. Grade with 50,000-psi yield exhibits welding properties similar to 0.20% carbon steel; other has properties similar to 0.10% carbon steel. Corrosion resistance equals that of mild, non-copper-bearing steels. Can be formed by bending across rolling direction, flanging and type of light forming performed on standard commercial sheet and plate. Thicknesses range from 0.0740 to 0.375 in.; widths, from 48 to 72 in.; and lengths (for widths 22 in. and over), from 280 to 307 in. **Armco Steel Corp, Middletown, Ohio.**

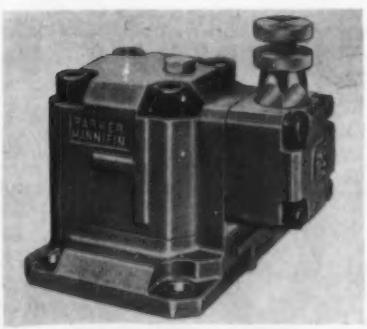
Circle 311 on Reader Service Card



Treadle-operated foot switches

are designed for ac and dc pilot-circuit control. Contact mechanism has SPDT, twin-break, silver NO and NC contacts enclosed in molded phenolic block. Standard-duty switch is 2-position, spring return, front treadle-operated unit. Heavy-duty switch contains two contact blocks and is side treadle-operated. Can be adjusted from 3-position spring return to 2- or 3-position maintained contacts. **Cutler-Hammer, 296 N 12th St, Milwaukee.**

Circle 312 on Reader Service Card



Hydraulic relief valve . . .

has adjustment control in any of four positions and captive pilot design for adjustment during operation. Line-mounted model is rated at 3000 psi; gasket-mounted model, 5000 psi. Both come in 20- and 50-gpm capacities based on hydraulic oil viscosity of 150 SSU at 100 F. Max operating temperature is 160 F. Can be mounted in any position. **Parker-Hannifin Corp, 17325 Euclid Ave, Cleveland 12.**

Circle 313 on Reader Service Card

continued on page 81

CONTROL

New! Space savingest relay you've ever seen: New Cutler-Hammer "Compact 300"

Cutler-Hammer's new, versatile 300 volt 6 amp., industrial control relay is so reliable it's permanently sealed. Bifurcated contacts add even more millions of operations.

So compact you can get 8 circuits in a panel space only 2" wide by 2¾" high. 2, 3, 4, 6, 8 poles with any combination of N.O. or N.C. contacts available. Add new "mechanical memory" latch at any time. Same life as relay. Get full details in PUB. LO-79-A249.

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CUTLER-HAMMER

Cutler-Hammer Inc., Milwaukee, Wisconsin • Division: Airborne Instruments Laboratory • Subsidiary: Cutler-Hammer International, C. A. Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.

CIRCLE 204 ON READER SERVICE CARD

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High performance, economical static seals, TETRA-SEALS are equal in quality to, and interchangeable with, standard O-rings. Available in natural, synthetic and silicone compounds to meet MIL, AMS, SAE, ASTM and industrial specifications.

O-RINGS

of

SILICONE RUBBERS HAVING SAME SHRINKAGE AS ORGANIC RUBBERS

Now, dimensions and tolerances of AN, MS, SAE, JIC and NAS met consistently with standard tooling from compounds useful over a temperature range of —80°F to +500°F. Non-toxic, too. Lower unit costs, fewer rejects, faster delivery, are other advantages.

For more details, ask for free literature on TETRASEALS and O-RINGS.

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METAL PLAN FILE

Keep Your Drawings Flat and Clean

Mayline metal plan files have hinged dust covers that stay in upright position when drawings are being removed or inserted in drawer—leaves both hands free. Drawers operate freely on muted ball bearing rollers.

For space saving economy Mayline plan files can be attached to the 4-Post or the May-O-Matic tables. Metal and wood plan files described in folder S-20. Your local dealer has this information for you.

Mayline Co., Inc.

607 No. Commerce St.

Sheboygan, Wisconsin

WOOD PLAN FILE

MAYLINE

MAYLINE

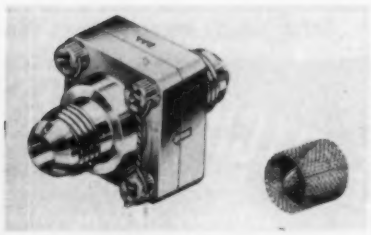
MAYLINE

CIRCLE 205 ON READER SERVICE CARD

½-in. motor compressor, vacuum pump . . .

is said to deliver more free air than other same-hp rotary, diaphragm or piston units. One oilless model has 1.9-cfm displacement and continuously operates up to 27-in. vacuum; another has 1.43-cfm displacement at up to 65-psig pressure. Automatic overload-prevention mechanism averts motor failure in event of abnormal electrical conditions. Clearance factor between piston and cylinder head eliminates need for safety valve. Operates at 1725 rpm with split-phase, induction-type motor. Priced at $59.50. **Bell & Gossett Co, Morton Grove, Ill.**

Circle 314 on Reader Service Card



Miniature filter . . .

suitable for most elements and blends, including food products, operates with 2250-psi gases and withstands temperatures of −350 to 500 F. Has 1.2-sq in. filter surface, of which approx one-half is open flow area. Teflon washer seals together halves of stainless steel body. Measures 1¼ in. sq and approx 2 in. long. Size ranges fit ¼ and ⅜-in. tubes. **Dumont Engineering Corp, 1401 Freeman Ave, Long Beach, Calif.**

Circle 315 on Reader Service Card

4P, Shaded-pole gearmotor . . .

is available in 1/30, 1/60 and 1/100 hp and in nine speeds of from 1 to 200 rpm. Measures less than 6-in. long, less than 4-in. dia and weighs between 4 and 6 lb. Fancooled with precision gears and oil-impregnated bronze bearings. **von Weise Gear Co, 9253 Watson Industrial Park, St. Louis.**

Circle 316 on Reader Service Card

Mounting cleats . . .

are sized to accommodate all Bureau of Ordnance Series rotating components. Machined from No. 303 stainless steel bar or cast with No. 416 heat-treated stainless steel. From stock. **PIC Design Corp, 477 Atlantic Ave, East Rockaway, NY.**

Circle 317 on Reader Service Card

Heat-setting adhesive . . .

bonds plastisols—liquid vinyl molding compounds—to metals, glass, ceramics and other surfaces. Synthetic resin-type material marketed as a 30% solid (can be cut with solvents to 15% solid) also adheres rigid molded vinyl and plastic sheeting to other surfaces. Bond reportedly will not break unless plastic is torn. Available in 5-gal pails and 50-gal drums. **Chemical Div, Goodyear Tire & Rubber Co, Akron.**

Circle 318 on Reader Service Card

1-in.-dia motor . . .

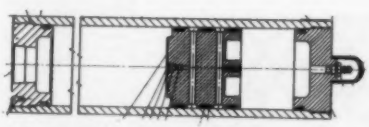
for battery-powered equipment is available for any voltage between 4.5 and 30 v dc. Governed speed is from 1500 to approx 5000 rpm and torque is from 0 to 0.20 oz-in. Current requirement is dependent on load, but customarily expressed in milliamp. Suitable for operation in ambient temperatures up to 200 F. Can be furnished for either clockwise or counterclockwise rotation. **Barber-Colman Co, Motors & Components Div, Rockford, Ill.**

Circle 319 on Reader Service Card

Elapsed-time meter . . .

indicates total time that a particular circuit is energized. Registers up to 99,999.9 hr. All digits are white on black, except tenths digit, which is black on white. Available with or without reset knob and can be mounted from either front or back of panel. **Westinghouse Electric Corp, PO Box 2099, Pittsburgh 30.**

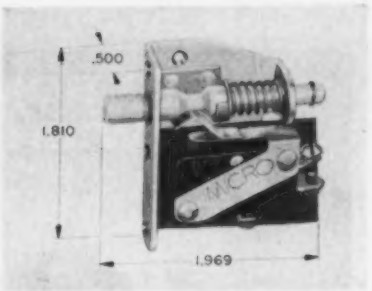
Circle 320 on Reader Service Card



3000-psi accumulator . . .

has three O-rings which dynamically separate fluid from gas. Tri-ring construction also eases squeeze on individual rings. Check valve feedback system eliminates pressure buildup between rings, which remain in dynamic balance regardless of how rapidly piston is operated. Capacity ranges from 10 cu in. to 23 gal. **Gabriel Co, 1148 Euclid Ave, Cleveland 15.**

Circle 321 on Reader Service Card



Door interlock switches . . .

automatically cut power to electrical components when service door is opened and turn it back on when door is closed. Circuits can be checked with power on by pulling out actuator rod to "maintained contact" position. Need no jumpers or cheaters. Rated for 10 amp at 125 or 250 v ac; ½ amp at 125 v dc and ¼ amp at 250 v dc; and ½ hp at 250 v ac. Travel is approx 0.250 in. on push; 0.187 in. on pull. Prices range from $2.88 to $7.10. **Micro Switch Div, Minneapolis-Honeywell Regulator Co, Freeport, Ill.**

Circle 322 on Reader Service Card

Heat and oxidation-resistant graphite . . .

is suitable for parts that operate in oxidizing atmospheres at up to 1200 F. During tests in 1200 F air, material showed weight loss of less than 6% after 200 hr. Does not melt or fuse at any temperature. Volatilization or sublimation takes place at 6332 F. Can be formed into shapes ground to 0.005-in. or less tolerances and lapped and polished within few millionths of an in. **United States Graphite Co, Div Wickes Corp, Saginaw, Mich.**

Circle 323 on Reader Service Card

Snubber-tube fitting . . .

protects gages and other instruments from damage caused by pulsating pressures. Can be a liquid and gas filter, particularly in low flow lines. Sizes range from ⅛- to ¾-in. OD. **Crawford Fitting Co, 884 E 140th St, Cleveland 10.**

Circle 324 on Reader Service Card

Electric-cable reels . . .

pay out and take up 15 ft to over 1 mile of cable. Conductor capacities range from 1 to 90. Available in explosionproof construction. **Aero-Motive Mfg Co, 1801 Alcott St, Kalamazoo, Mich.**

Circle 325 on Reader Service Card

Plate-type truck caster . . .

suitable for applications where casters can become entangled in threads, lint, fibers or other material, has ⅜-in. clearance between

continued on page 83

USE THE NEW

METLBOND 406

today's most advanced metal-fastening adhesive system

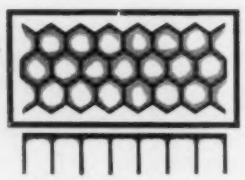
METLBOND 406 is a large-area, one-component, low-pressure, dry, epoxy-based adhesive system. METLBOND 406 will bond similar or dissimilar metals faster, cheaper, better. No core or skin primer is required. And, since it releases no volatiles during cure, non-perforated sandwich core can be used. In airframe fabrication, drastic reductions can be made on the chances of progressive moisture condensation within wing panels or control sections. For any structural metal-joining operation, use METLBOND 406 – the "educated" adhesive. It can measurably cut your fabrication costs.

IMPORTANT CHARACTERISTICS OF METLBOND 406

Effective operating temp. range .... —430F to +200F
Room temp. shear strength ...5500 psi
Room temp. peel strength (in.-lbs per 3-in. width) 125
A dual-purpose adhesive system which can be used to bond metal-to-metal, or core-to-skin with equal effectiveness.

METLBOND 406 IS EASY TO USE. It can be cut, placed in position, and cured with low pressure, at moderate temperatures. Since it is a non-supported system, there is no fabric carrier. Therefore, during cure, it flows... goes where you want it!

FILLETING ACTION OF METLBOND 406



It fillets, clings, and seals off each cell wall.

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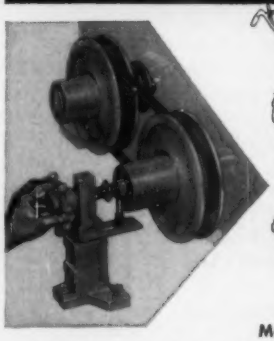
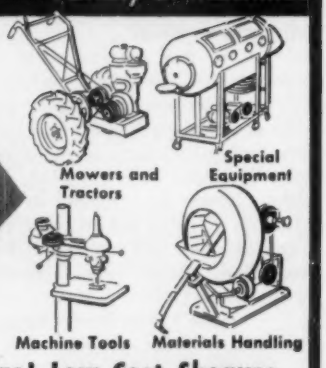
Control Speeds on Variety of Machines





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thread guards and legs. Lint and threads fall freely through horn and any possible accumulation can be cleaned out without removing wheel. Thread guards have no recesses or projections. Step in wheel's web, plus close fit of thread guard eliminate possibility of threads and lint binding wheel. **Bassick Co, 3045 Fairchild Ave, Bridgeport 5, Conn.**

Circle 326 on Reader Service Card

Socket Setscrews . . .

with knurled points are available from stock in any size and quantity; with spline heads, in sizes 4 to ⅜-in., min orders of 5000 or more in one size. Distributed nationally. **Safety Socket Screw Co, 6501 N Avondale Ave, Chicago 31.**

Circle 327 on Reader Service Card

Polyurethane foam moldings

withstand temperatures from —20 to 300 F and are said to be moistureproof and abrasion-resistant. Urethane densities, both flexible and rigid, range from 2 to 7 lb. Linear configurations also are molded and covered. Production limited to small sizes. **Joslyn Mfg Co Inc, Macedonia, Ohio.**

Circle 328 on Reader Service Card

Miniature solenoids . . .

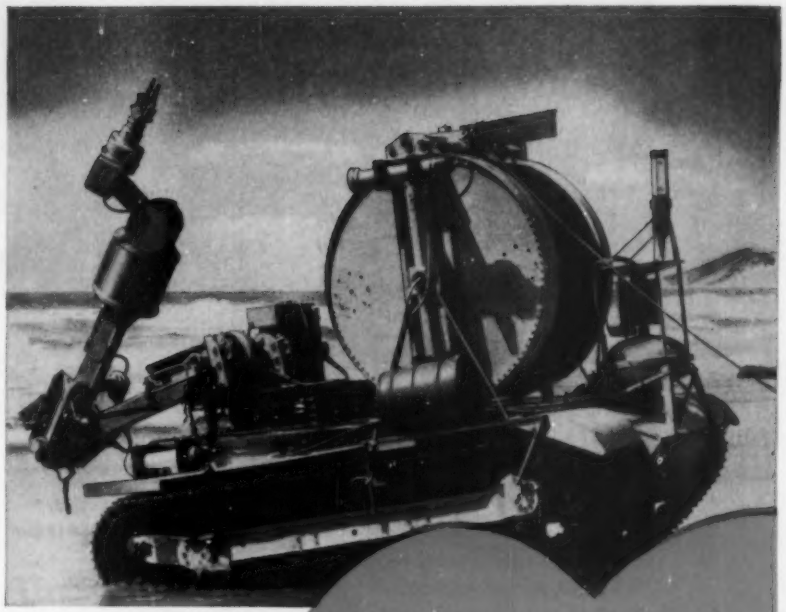
for use in digital computers, printers, punched-tape block readers, etc. have dia of ¼, $\frac{5}{16}$, and ½ in., voltages of 6, 12, 24, 36, 115 and 230 v dc and power ratings of ¼ w and up. Said to meet requirements of MIL-S-4040C. **Cannon Electric Co, 3208 Humboldt St, Los Angeles 31.**

Circle 329 on Reader Service Card

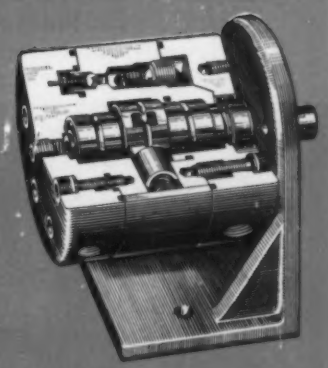
Hydraulic leakmeter . . .

measures leakage of 0.0025 cc. Connects into line between test item and up to 5000-psi fluid supply. Leakage displaces piston which is separated from working fluid by bellows. Displacement (max, 2 cc) is measured by position transducer and displayed on volume-indicator dial. Timer allows selection of automatic operating periods of from 15 sec to 5 min. Over max time period, leakage flow rates as small as 0.0005 cc/min. can be

continued on page 85



REMOTE UNDERWATER MANIPULATOR BUILT FOR THE U. S. NAVY BY THE SCRIPPS INSTITUTION OF OCEANOGRAPHY OF THE UNIVERSITY OF CALIFORNIA AND THE HUDSON LABORATORIES OF COLUMBIA UNIVERSITY.



This hardy HYDRAULIC HEART operates efficiently even 20,000 ft. under water

The Heart of this Exotic Ocean Explorer Is a RACINE
MODEL D8 PUMP

A RACINE pump actuates the mechanical arm on the Remote Underwater Manipulator, a new experimental vehicle the U. S. Navy uses to explore the ocean floor down to depths of 20,000 ft. The arm makes all the motions of the human arm and hand. It picks up samples from the ocean floor . . . assembles and installs instruments in the ocean depth. Land-based remote controls operate the underwater explorer. Rated at 1,000 psi continuous pressure, the RACINE pump automatically compensates for the compressibility of oil under various sea water pressures. When you need *versatile* hydraulic components — sturdy and dependable for *any* use from research to assembly line — your best choice is RACINE!

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HYDRAULICS DIVISION

Reevecote broadens use of popular air switch with stronger—more sensitive diaphragms

T. H. Landgraf, Chief Engineer at The Autogas Company of Bellwood, Illinois, says: "The use of a Reevecote diaphragm allows a wider range of control of all kinds of gases, wider temperature range and provides greater strength."

The Shure-Vent Control, product of The Autogas Company, is an increasingly popular air-flow interlocking switch. It is actuated by a strong, sensitive Reevecote diaphragm. Operation is by pressure or vacuum.

Since the heart of this control is its diaphragm, The Autogas Company found the perfect solution in a larger, stronger, more sensitive diaphragm made of Reevecote, a synthetic rubber-coated fabric manufactured by Reeves Brothers, Inc.

If your design calls for a diaphragm – or the use of coated fabrics . . . choose from over 200 styles of Reevecote – the most complete line of coated fabrics for industry.

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CIRCLE 84 ON READER SERVICE CARD

ALL CASTERS ALIKE?

Series "23" "LOCKWELD" double ball race casters. 3"-8"

Series "21" single ball race casters. 2"-6"

Fairbanks "LOCKWELD" Casters are the different casters—the casters without the king-pin—the casters without the major cause of caster failures.

Fairbanks "LOCKWELD" Casters are stocked, sold and recommended by leading distributors in all the principal cities across the nation. Call your distributor today and ask him to show you how the patented "LOCKWELD" Casters will save you maintenance and replacement costs.

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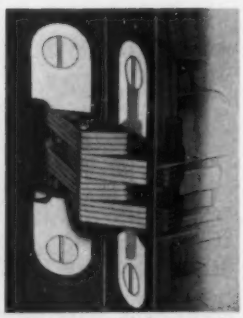
CIRCLE 208 ON READER SERVICE CARD

NEW INVISIBLE HINGES

General Purpose Hinge Creates Flush Surfaces



These hinges are completely hidden from view when door, lid or hood is closed. Makes possible flush, absolutely smooth surfaces that greatly enhance appearance and safety. Tapered body sections are precision castings of a special zinc base alloy having a tensile strength of 47,000 pounds per square inch. Operates in a 180 degree arc which permits full opening. Laminated link construction reduces friction and permits hinges to operate freely and smoothly. Hinges are reversible and may be used right or left hand. Available for wood or metal application in a wide variety of sizes. For complete details, prices and free illustrated catalog, write today to

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P. O. Box 38. Harper Station, Detroit 13, Mich.

CIRCLE 209 ON READER SERVICE CARD

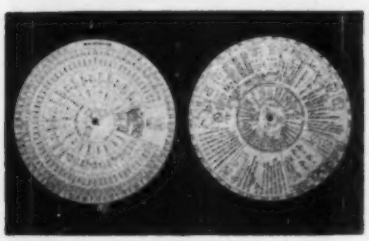
measured. Priced at $2650. Convair Instruments, General Dynamics Corp, 3595 Frontier St, San Diego 10, Calif.
Circle 330 on Reader Service Card

Drafting tables . . .

have completely counterbalanced tops even if drafting accessories are added. Adjustable-quadrant springs govern change of tilt. Properly adjusted, tops with go through angle movements as though no change had been made in original weight. Control works on both linoleum-covered steel or metal edge, all-basewood tops. One model desk is 29 in. high and can be raised to height of 38 in. Another has min height of 37 in. with additional 9-in. movement upward. Mayline Co Inc, Sheboygan, Wis.
Circle 331 on Reader Service Card

Underlay guides . . .

available in set of 27, show circles from ¼ to 6-in. dia at viewing angles from 5 to 70° with 2½° steps. Said to be accurate at a viewing distance of 30 in. Calibrations enable guides to also be used as perspective protractors. Priced at $4.75. Graphicraft, PO Box 509, Westport, Conn.
Circle 332 on Reader Service Card



Circular calculator . . .

is a 7-in. dia unit containing such information as: decimal equivalents of fractions; illustrated dimensions of round, flat, socket or fillister head screws and nuts; tap drills and threads per in. of NC and NF screws; decimal size of both letter and number drills; and diagrammed formulas for solutions to triangles and areas or volume of such basic forms as circles, trapezoids, cones, etc. Priced at $1. Pierce Mathfaster Calculator, Box 837, Arleta, Calif.
Circle 333 on Reader Service Card

High-speed diazo-blue paper

is formulated with broad light-absorption compound that allows 20 to 25% faster exposure speed with no loss in line density. Yields bright blue image on white background. Develops fully at printing speed. Tecnifax Corp, Holyoke, Mass.
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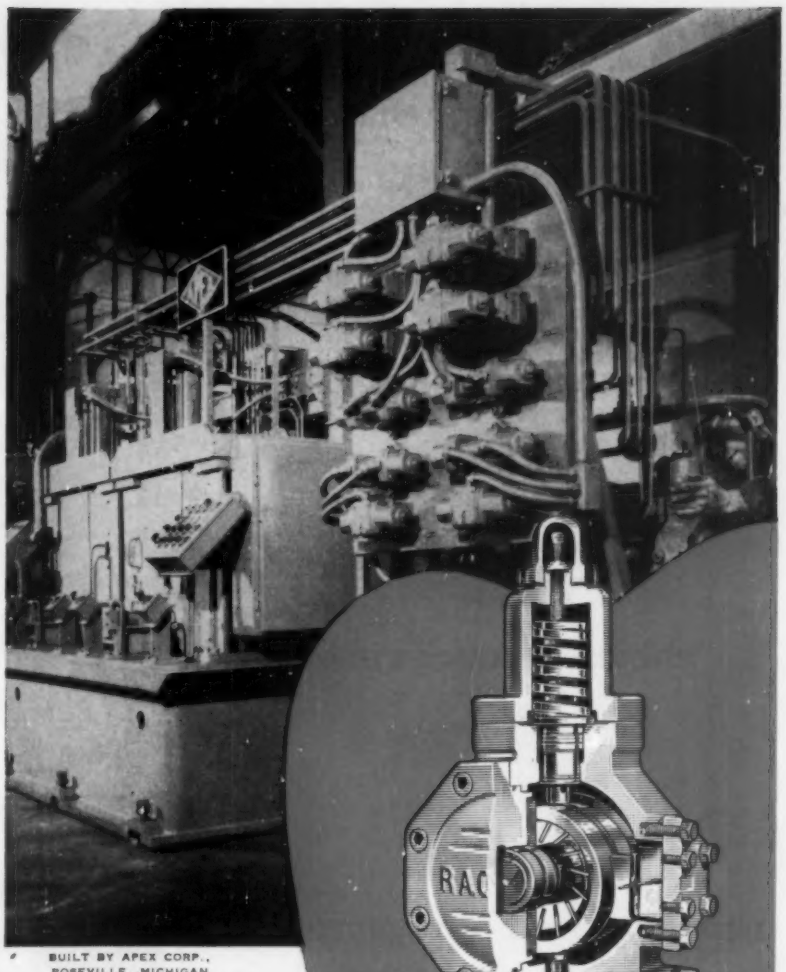

BUILT BY APEX CORP., ROSEVILLE, MICHIGAN

This active hydraulic heart helps

the HEART of this impregnating machine is a RACINE MODEL 6FA PUMP

SEAL POROSITY IN 106 TRANSMISSION CASES EVERY HOUR

A RACINE VARIABLE VOLUME PUMP and 10 RACINE VALVES control *all* mechanical operations in this Apex impregnating machine, which seals leaky transmission cases at a major auto firm's transmission plant in Toledo, Ohio. Apex specified RACINE equipment because its design simplifies machine design problems . . . eliminates the need for extra pumps and valves. RACINE PUMPS are easy-to-control . . . handle pressure compensation *automatically* for varying gpm requirements. Apex has *preferred* RACINE for over 10 years!

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86 CIRCLE 86 ON READER SERVICE CARD

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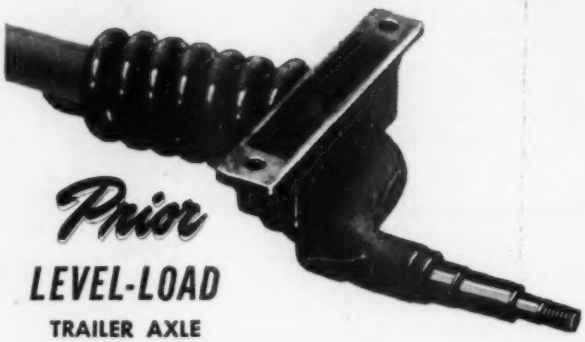

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75 kw; 100 kw.

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2 kw; 4 kw; 7½ kw;
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Reprints currently available without charge are listed on the Reader Service Card bound in this issue. Single copy free; quantity prices on request.

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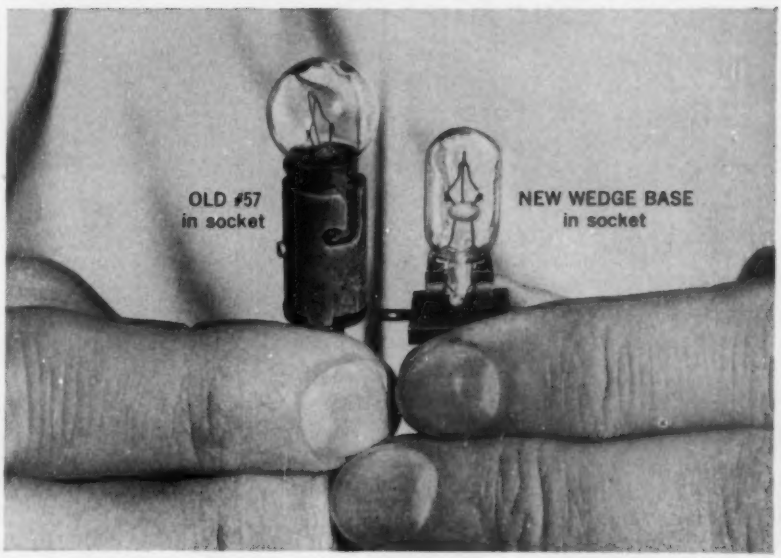
NEW G-E "WEDGE BASE" LAMP SAVES SPACE, SAVES MONEY, SAVES TIME, SAVES MANPOWER



The new "Wedge Base", all-glass, incandescent indicator lamp is an exclusive G-E development designed to replace the old #57 and other similar bayonet-based lamps. It's available in 6.3 and 12 volts. See below.

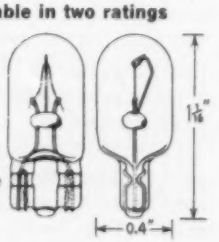
The Wedge Base saves space because, with its holder, it is considerably smaller than the old #57. It saves money because the holder and total installation costs are less. It saves time because the holder is easier to install and the lamp can be seated with just a push. And it saves manpower because installation can be automated and holders can be molded into plastic circuits. The G-E Wedge Base lamp can withstand ambient temperatures up to 600°F because it has no basing cement.

A major automobile manufacturer is already using G-E Wedge Base lamps; they're available in mass quantities. For more information write: General Electric Co., Miniature Lamp Department M-12, Nela Park, Cleveland 12, Ohio.

The Wedge Base is available in two ratings

G.E. Lamp No.	158	159
Circuit Volts	12	6.3
Amperes	0.24	0.15
Design Volts	14	6.3
Rated Av. Life at design volts	500 Hrs.	*
Filament	C-2V.	C-2R
L.C.L.	½"	½"
Bulb	T-3¼	T-3¼
Base Type	Wedge	Wedge
Candlepower	2	.35

*In excess of 5000 hrs. at 6.6 volts



Progress Is Our Most Important Product

GENERAL ELECTRIC

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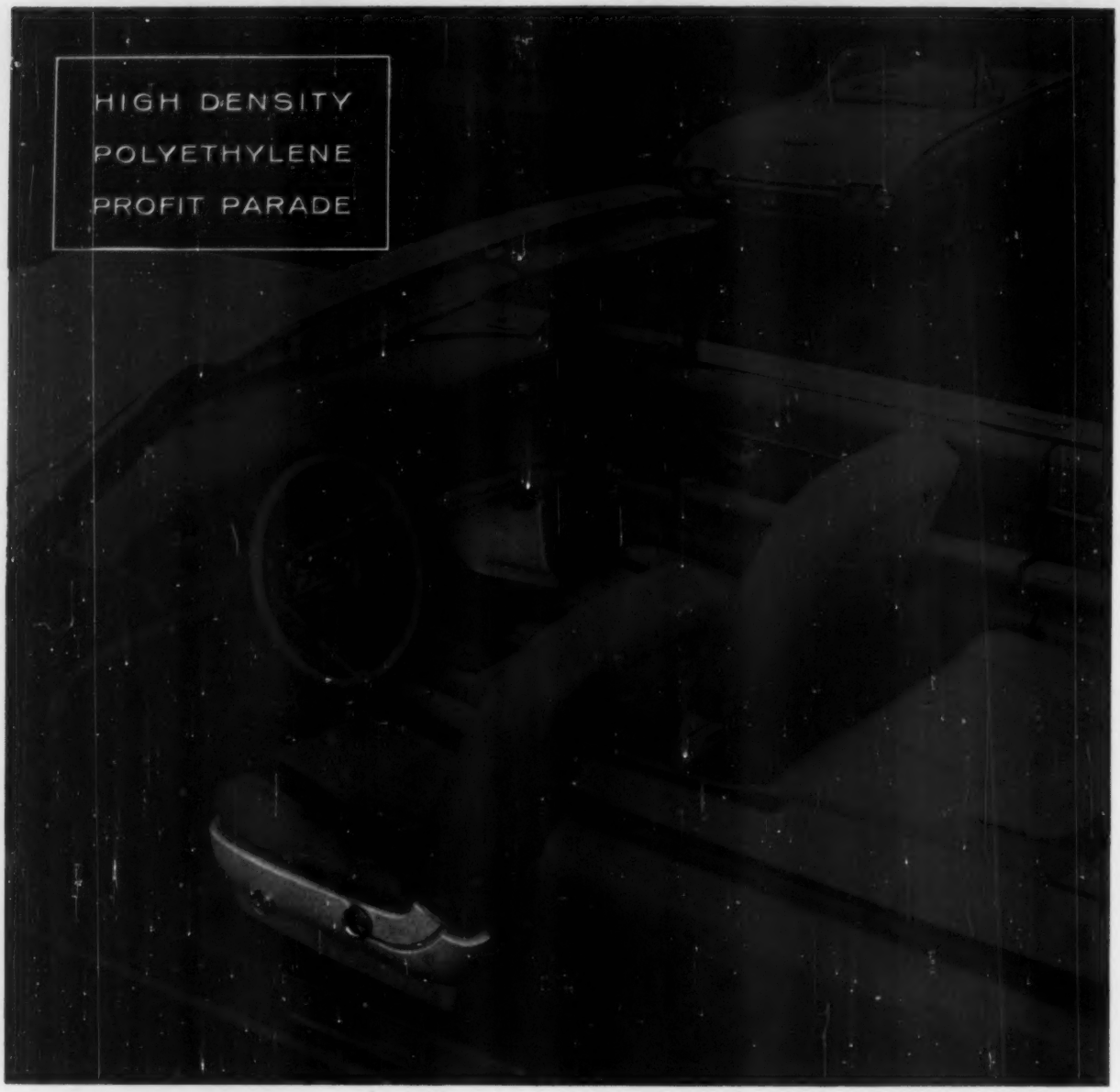

Grace Plastic Adds to Lasting Value of Classic Car

The beautiful, classic Thunderbird is a king in Ford Motor Company's famous line. And as befits a king, all its parts and appointments are made with special care, for lasting beauty, value and service . . . while maintaining realistic economies.

Example: Grex High Density Polyethylene is a material used in three "show" parts of this '61 model—in the side cowl cover, the side seat shield, and the pivot cap on the seats. Besides having smooth beauty, these parts also must be scuffproof. And they must be perfectly color-matched with other parts of the interior.

Grex is an excellent material for components such as these, where beauty, duty and economy of fabrication must go hand in hand. Grex can be formed by any conventional fabricating technique, in any color. It takes day-after-day punishment without chipping, cracking or breaking. It can undergo extremes of temperature without losing its strength or shape. And most important of all, it adds beauty and value to this car.

If you need the special advantages of high density polyethylene, don't overlook the experts. Grace has the production facilities, technical service and experience to help with demanding components problems. And we're easy to do business with.

Grex is the trademark for W. R. Grace & Co.'s Polyolefins

W.R. GRACE & CO.
POLYMER CHEMICALS DIVISION
CLIFTON, NEW JERSEY

'61 Thunderbird sets
a standard for value.

Color is critical. As every auto buyer knows, cars are made in almost every color of the spectrum. Ford, in its Thunderbird line alone, uses 6 colors. Grex already has been supplied in all of these approved colors.

Matching colors to the most critical standards requires ingenuity, patience and experience. For colors must not only pass stringent visual tests under the Macbeth light, but must stand the test of time as well.

Wearing qualities essential. There would be little virtue to parts made of Grex if they merely appealed to the eye. All the parts are in "wear" locations, and are subject to scuffing or continual flexing. The problem of scuffing is overcome with a handsome, textured, leather-like effect. Scuffs literally "bounce off." This textured pattern was engraved in the irregular surface molds by photo arc.

The side cowl cover presented a special problem. It is thin-gauge, yet has large surface area. High density polyethylene was selected as the material for this part because it resists abrasion, withstands flexing, and has native toughness, even in very thin, large-area sections.

Why not use some other material? High density polyethylene has special advantages in applications like these. It requires no additional surface finish, and gives close color match. It has a warmth and solidity lacking in other materials. It doesn't chip, crack, or peel. Perhaps most important, it maintains economies while actually improving the quality look of components.

What about you? The problems present in this application can be applied profitably in other products. Luggage, for instance. And housewares, appliance components, quality toys. If you'd like a profitable answer to a high density polyethylene question, just write us:

Technical Service Department
Polymer Chemicals Division
W. R. Grace & Co., Clifton, N. J.

DESIGN LITERATURE

Russian Science in the 21st Century

Edited by Sergei Gouschev Mikhail Vassiliev. McGraw-Hill Book Co Inc, 330 W 42nd St, New York 36. 6 x 8, 222 pp. $4.95.

Some reviewers have compared this volume to Hitler's *Mein Kampf* and see in it an equivalent manifesto worthy of serious study right now. It is a series of interviews by the editors with 29 members of the Soviet Academy of Sciences, each a specialist in some field of science. It is a series of dreams of the world 50 years from now, based on what we know and dream today. It is a series of statements that will seem incredibly dated in 25 years, in all probability, because it contains a great deal of the atmosphere of the World of Tomorrow in New York's 1939 World's Fair. It also contains a great deal of food for thought for Americans—whom it practically never mentions.

We couldn't have written it—we have no equivalent group of geopoliticians, nor an equivalent belief that geopolitics is based on science, nor a spokesman for technology who would say, as Nessmayanov, president of the Soviet Academy, did: "The greatest danger of all is . . . *not* to look ahead, *not* to see, and *not* to set for oneself a bold goal."

Among other forecasts is steel made by computer from iron dust in a continuous process; the various alloys tailor-made, atom by atom, through nuclear radiation. The Soviets expect to end coal mining—to gasify the coal *in situ*, drilling down to it by electrical discharge, supplying high-pressure air to the seam and lighting off the coal electrically. They expect to force oil to convenient sites for extraction, to heat streets electrically to avoid snow removal, to have autos that move 200 mph under voice direction. And computers will run the whole lot.

There are, as always, curious contradictions. They talk of bloodless surgery, surgical glue and stored spare parts for the body rather than of disease prevention. They talk of reducing sleep hours to add 20 or 30 years to life, but not a word of the cultural education possible in the time so gained. They talk of giant carrots and cabbage, not of concentrated food. They talk of planes and still of widergage railroads, of artificial suns to light cities and yet of street lights fastened to houses. All in all, it's reminiscent of the varied opinions offered by most medical specialists about the cause of debility.

No, this isn't a book to challenge *Mein Kampf* as a blueprint or master plan for the future. *Mein Kampf* was the program of a single man who could implement his ideas; this book is the program of a committee—which inevitably breaks into divergent elements when forecasting. It is still, however, the best compilation this reviewer has seen of forward-looking technological ideas. —EJT

Electronic Maintainability, Vol 3

F L ANKENBRADT, EDITOR, Radio Corp of America. Engineering Publishers, PO Box 2, Elizabeth, NJ. 6 x 9, 312 pp. $10.

This book is based on the Third Electronic Industries Assn Conference on Maintainability of Electronic Equipment. Subject matter ranges from the maintenance problems of space flight to the determination of adequate working space for electronics technicians. The contributors are among the foremost workers in the field.

Other Books of Interest

Electrical Engineering Problems

Williams, Young. McGraw-Hill Book Co Inc, 330 W 42nd St, NY 36. 6¼ x 9¼, 294 pp. $7.75.

A collection of problems used at Carnegie Institute of Technology for various courses, such as circuits, electronics and mechanics.

Adventures in Algebra

Crowder and Martin. Doubleday & Co Inc, 575 Madison Ave, NY 22. 5¾ x 8½, 350 pp. $3.95.

This is part of a series of instruction books intended for self-study.

Modern Economic Analysis

William Fellner. McGraw-Hill Book Co Inc, 330 W 42nd St, NY 36. 6 x 9¼, 459 pp. $7.50.

This book presents modern economic micro- and macro-theory, including business cycles, theory of economic growth, essentials of welfare economics. Has been used in author's classes at Yale University.

continued on page 91

Gear pump components just before assembly. All parts received Colmonoy hard surfacing in areas subject to wear.

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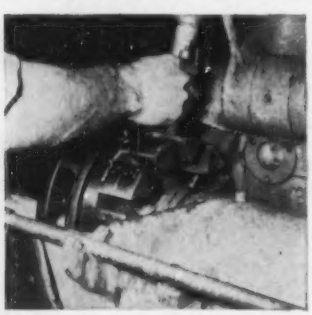

Above: The Colmonoy Sprayweld unit. Left: Colmonoy overlay on pump rotor being finish ground. Below: The Spraywelder Catalog and Colmonoy Manual. Ask for them.

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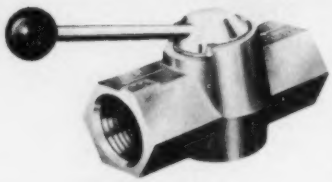

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Accelerators—Machines of Nuclear Physics

R R Wilson, R Littauer. Doubleday & Co Inc, 575 Madison Ave, NY 22. 4 x 7, 196 pp. 95¢.

A discussion of these research machines intended for students of science.

The Watershed

Arthur Koestler. Doubleday & Co Inc, 575 Madison Ave, NY 22. 4 x 7, 280 pp. 95¢.

A biography of Johannes Kepler (1571-1630), the founder of modern astronomy, by a prominent novelist for the science student.

ABSTRACTS FROM THE LITERATURE

Transient Lubrication

An analytical solution is obtained for the transient pressure developed in a slider bearing without side leakage when one of the bearing surfaces is accelerated tangentially. The lubricant is assumed to be incompressible and to have constant viscosity, and the film thickness is assumed to remain fixed in time.

"Transient Lubrication of an Accelerated Infinite Slider," Lyman, Saibel, Rensselaer Polytechnic Institute. American Society of Lubrication Engineers Paper No. 60 LC-12, 5 N Wabash Ave, Chicago 2.

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"Determination of Thickness of Babbitt Lining for Friction Bearings," Smirnow, B. I. Translation of Vestnik Mashinostroyeniya (USSR) '58 vol 38, no 6, p 26-28. Available from Photoduplication Service, Publication Board Project, Library of Congress, Washington 25, DC.

The Edsel

Two-part article details the development, short life (only 109,466 cars sold in 26½ months) and demise of the Edsel. As the author admits, his story may not be entirely accurate—Ford Motor Co displayed "understandable reticence"—but this is certainly one of the most readable case

continued on page 92

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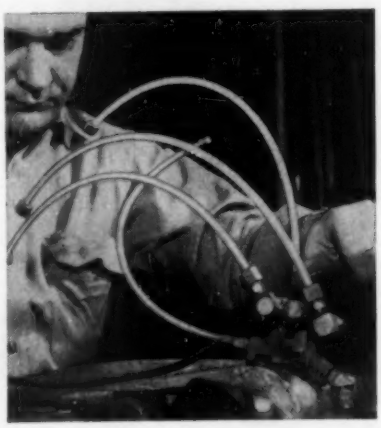

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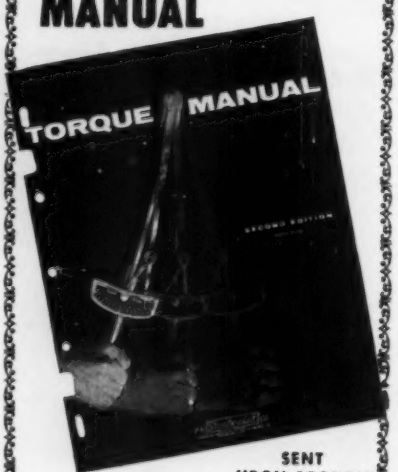

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Adapter Problems
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CIRCLE 215 ON READER SERVICE CARD

histories of product development. Of particular interest to engineers because of the way design and engineering were subordinated to public-opinion polls, motivation research and executive caprice; and because that most engineers have to buy and drive auto-industry products.

"The Edsel," John Brooks. The New Yorker, Nov 26 and Dec 3, '60, 25 W 43rd St, New York 36.

CATALOGS AND BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover.

BALL-BEARING SCREWS AND SPLINES—Data book 61-E, 24 pp. Describes and illustrates design characteristics, types and applications. Size ranges and load capacities are tabulated, while curves show life and hardness factors, limit column loads and critical speeds. Actuator Operation, Saginaw Steering Gear Div, General Motors Corp, Saginaw, Mich.

Circle 350 on Reader Service Card

TWO-DIRECTIONAL DRIVE UNITS—Catalog RL-101, 22 pp. Reviews components and construction, operating principles, design advantages, etc. of dual-torque locking and positioning devices. Treats breakaway torque; overhauling, thrust and radial loads; torsional windup; and service factors. Eight applications are depicted in schematics, while specifications are given for 17 models. Formsprag Co, 23601 Hoover Rd, Warren, Mich.

Circle 351 on Reader Service Card

NYLON STOCK SHAPES—Brochure, 8 pp. Lists rod, plate, sheet, strip and tubing sizes and tabulates physical properties of four nylon grades. Charts compare general-purpose nylon with polyethylene and cellulose acetate butyrate in ultimate tensile strength, modulus of elasticity in tension, Rockwell R hardness scale and heat distortion temperature. Cadillac Plastic & Chemical Co, 15111 2nd Ave, Detroit 3.

Circle 352 on Reader Service Card

ALUMINUM CASTING ALLOY—Brochure 103R5, 8 pp. Gives specifications, nominal composition, and physical and mechanical properties of high-strength, self-aging alloy. Contains data on casting, dimensional stability, corrosion resistance, machineability and welding, brazing and plating techniques. Federated Metals Div, American Smelting & Refining Co, 120 Broadway, New York 5.

Circle 353 on Reader Service Card

GRAPH SHEETS—Catalog, 92 pp. Contains color reproductions and size lists of cross-section and profile papers, cloths and films. Discusses selection of grid patterns suitable for plotting business statistics, scientific data, sketching and drawing and surveying and mapping. Keuffel & Esser Co, 3rd & Adams Sts, Hoboken, NJ.

Circle 354 on Reader Service Card

ELECTRIC DISK BRAKES—Bulletin 605B, 8 pp. Offers dimensional drawings and specifications of five series with torque ranges of from 1 to 575 lb-ft. Includes brake selection guide. Stearns Electric Corp, 120 N Broadway, Milwaukee 2.

Circle 355 on Reader Service Card

TOGGLE CLAMPS—Catalog 77, 36 pp. Contains dimensional drawings and holding pressure and weight information on 65 toggle action, plunger action, air- or hydraulic-operated and portable models. Accessories price list is illustrated. Detroit Stamping Co, 330 Midland Ave, Detroit 3.

Circle 356 on Reader Service Card

PHOTOELECTRIC CONTROL—Bulletin PE-7, 2 pp. Lists applications and electrical requirements for six electronic timer-scanner relay systems. Schematics illustrate timing action and adjustment data. Farmer Electric Products Co Inc, 2300 Washington St, Newton Lower Falls, Mass.

Circle 357 on Reader Service Card

PLASTIC-ENCLOSED RELAYS—Engineering Bulletin 1010, 2 pp. Outlines electrical, mechanical and physical data on 20 stock relays with transparent dust covers. Includes plug and wiring diagrams. Ohmite Mfg Co, 3601 Howard St, Skokie, Ill.

Circle 358 on Reader Service Card

PINBOARD PROGRAMING PANEL—Bulletin 600, 2 pp. Traces electrical characteristics and lists device's potential applications in instrumentation, test and checkout equipment, and controls of all types. Gives specifications of both pinboards and pins, along with scale drawings. AMP Inc, Harrisburg, Penna.

Circle 359 on Reader Service Card

SILICONE-MODIFIED RUBBER—Technical manual, 48 pp. Outlines properties and performance of various compounds and gives results of oxyacetylene insulation flame tests. Stoner Rubber Co Inc, 10792 Knott Ave, Anaheim, Calif.

Circle 360 on Reader Service Card

GENERAL-PURPOSE RELAYS, SOLENOIDS—Bulletin GC-100, 4 pp. Offers coil, contact and other specifications of standard plate-circuit, economy and step-

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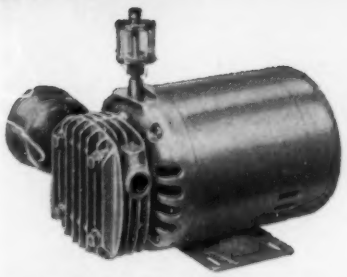

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ping relays. Photos and pull vs distance curves illustrate solenoid features. Artisan Electronics Corp, 171 Ridgedale Ave, Morristown, NJ.

Circle 361 on Reader Service Card

BRASS AND BRONZE CASTINGS—Folder, 4 pp. Lists 20 SAE brass and bronze alloys, their chemical composition and physical properties. Pictures full line of bronze bushings. Markey Bronze Bushing Co, Delta, Ohio.

Circle 362 on Reader Service Card

ELECTRICAL TAPES—Folder, 4 pp. Chart covers typical properties, standard slitting tolerances, standard lengths and military specifications of 31 tapes, ranging from paper to silicone rubber. Minnesota Mining & Mfg Co, 900 Bush Ave, St Paul 6.

Circle 363 on Reader Service Card

INDEXING TABLES—Catalog U-100, 12 pp. Contains dimensional drawings and traces operational features of 7-, 12- and 24-in. models with either horizontal or right-angle bases. AA Gage Co, 350 Fair St, Detroit 20.

Circle 364 on Reader Service Card

BIMETALLIC BONDING—Brochure, 12 pp. Discusses uses for process which molecularly bonds aluminum alloys to low carbon, alloy, and stainless steels, kovar, cast iron, and molybdenum. Covers bond's mechanical and thermal properties and its effects on steel. Al-Fin Corp, Bethel, Conn.

Circle 365 on Reader Service Card

9-SPEED TRANSMISSION—Bulletin 610-ED, 4 pp. Illustrates shift instructions and plots engine rpm against vehicle mph through nine forward gear ratios. Cutaway drawing shows arrangement of gears and shafts within casing. Clark Equipment Co, Transmission Div, Jackson, Mich.

Circle 366 on Reader Service Card

"He spilled coffee on it yesterday."

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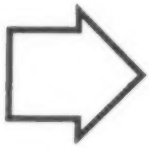

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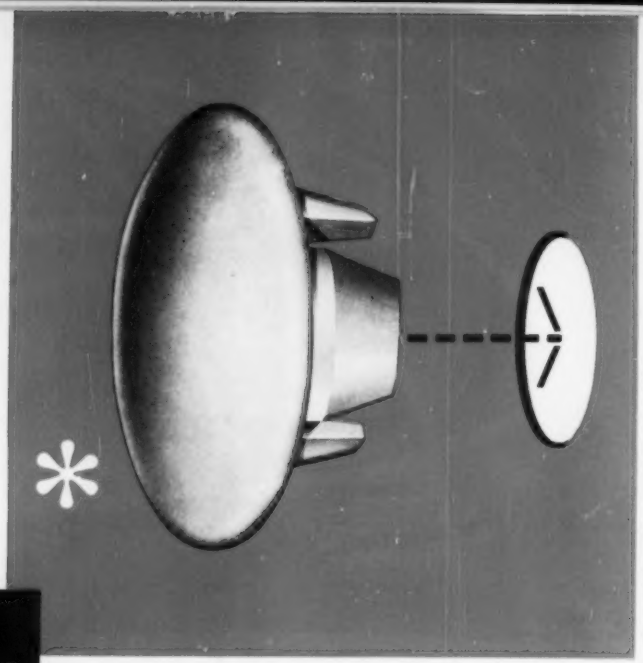

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